THE HIGHWAY GRADE CROSSING PROBLEM

By Robert H. Ford, Assistant Chief Engineer, Rock Island Lines, Chicago.

(Paper read before Western Society of Engineers, April 25, 1927.)

Before the advent of the automobile, the highway mileage consisted largely of public pathways meandering through the country without respect to curvature or gradients and with little regard for principles of economic location. The main thing was to permit horse-drawn vehicles eventually to reach their destination. Time and convenience, as understood today, were given little consideration, and except at special locations, the safety factor was not serious because of the slow vehicular movement.

Highway maintenance was in keeping with methods of location. The sun and wind were the two principal agencies, except in the larger communities. A vast mileage also served as a convenient medium for the farmer to work out his taxes. He could devote a few days now and then with his farm wagon in filling up the holes in the road, or in making crude repairs to the smaller bridges spanning the waterways.

But, overnight, as it were, a great mileage of modern highways has been developed. Roads have been transformed from country lanes into broad thoroughfares, graded, drained, and paved in the most approved fashion, and constructed at costs which rival the cost per mile of a modern steam railroad, with track, bridges and signals complete.

The public highways of the United States may be grouped about as follows:

1. City Streets

Wholly within the control of municipalities, and supervised and directed by approximately 3,100 independent organizations.

2. Boulevards and Park Roads

Controlled by park commissioners and usually independent of municipal authorities with respect to standards, public markings, maintenance, etc. There are approximately 3,000 principal commissions of this character in our larger centers.

3. County Roads

Under the control of county judges, road commissioners, etc. Independent of each other and of any central body, and subject to their own views with respect to location of the roads and grade crossings thus created or closed, safety and convenience of the public, highway markings and standards, character of maintenance, etc. There are about 145,000 of these separate bodies in the United States in charge of highways.

4. State Highways

More or less under the control of state highway commissions and independent of municipal or county authorities. One in every state, or 48 commissions. Each state commission is a law unto itself with respect to location of roads or crossings, standards of maintenance, highway markings, etc.

5. Federal Roads and Highways

Controlled by federal agencies, and except for the state-aid roads, more or less independent of state, county or municipal authorities.

From the foregoing it will be seen that our highway systems are in the hands of over 150,000 unrelated bodies more or less independent of each other and political in their composition, except as they may, from time to time, delegate their powers to persons competent by training and experience in such matters.

It is not difficult, therefore, to understand why our grade crossing situation both at highway and railway intersections is in such a chaotic state. Also why our highway marking system is so widely different over the country, to the utter confusion of the traveller, or why there is no uniformity of standards for protection at railroad grade crossings. The excellent systems in some sections are neutralized by complete reversals of practices on other sections—to the bewilderment and danger of the highway user.

It also serves to throw some light on the reason why in 1926 there were 600,000 people injured and 20,819 killed in accidents on highways and at highway intersections; and 6,991 persons injured and 2,492 killed at railroad crossings in the United States.

Railroads Are Public Property

While the railway system will probably always remain the principal agency for transport, the newly developing highway system is of equal importance to the public, and is used by a vastly greater number of persons than either the waterways or the railways for profit and pleasure. These three systems comprise the great transportation mediums of the country.

There is in many respects, a striking similarity in the development of the American railway system and the fundamentals of the national highway system.

From small beginnings the railroads developed during the past 100 years until they now form a vast network spreading out over the States, and comprising 258,000 miles of main lines, feeder and branch lines equivalent to 8.68 miles per 100 square miles of area. The American railway system now rivals in every respect all transportation mediums of the entire world, a result which has been successfully accomplished in the face of steadily rising costs and without subsidy or assistance from federal, state or other public agencies. This is the direct opposite for its rivals, the waterways and highways transport system.

The three transport systems are essentially for public use and are owned by the public irrespective of the popular notion that its railway system is a private organism, for while true in a legal or technical sense, it is not so in public application. The fact is that 94% of railway ownership is distributed among hundreds of thousands of small holdings, or held in trust for the benefit of many millions of individuals while its securities now form one of the principal repositories for the savings of the small investor and for their trust and reserve funds principally through the medium of insurance companies, estates and similar agencies Ownership equities of the American railway system are in the hands of more than sixty millions of people and represent a much larger public holding than the securities of the public highway or water transport systems.

Railroads Have Unified Control

Meanwhile the wages which the railways must pay; the conditions under which its employes shall work; the rates which they may charge for services and the form and character of this service, are controlled by the general public through federal and state commissions set up for the purpose.

It will be seen, therefore, that the railways have, in reality, passed to public ownership in a much larger sense than many other public agencies and it is but a polite fiction to say that they are private organizations.

The American system of railway transport is directed by public opinion and so organized as to function as a single composite unit with respect to methods of operation, standards and practices of construction, maintenance and transportation. It works in close alliance with and functions through a dual organization consisting on the one hand of the Interstate Commerce Commission (representing the Government) and the state utility commission (representing the States) and on the other, through highly skilled railway administrators, developed by long processes of training and education in the science of transportation.

To keep this great system modernized and standardized there has been developed a powerful auxiliary force of experts who function as the American Railway Association, and who also work in close alliance with the Interstate and State commissions and the several railways or component parts of the national railway system. This expert organization is supervised by the executive officers of the individual roads and so subdivided and organized as to group together, for advisory purposes, specialists in every form of transport service, such as transportation, mechanical, engineering, signaling, maintenance, safety, etc. It is through these organizations that standardization and uniformity of practices are secured to keep the railway system in step with the needs of the country and immediately responsive in the production of safe and convenient transportation.

Highway System Not Coordinated

The highway system, in a similar sense, is also owned by the public, being one of its three great systems of transportation and equally necessary for its convenience. It is built and maintained by public funds and now comprises 2,862,197 miles of roads, exclusive of streets and park road mileage in communities with a population of 2,000 or over. These roads may be divided as follows:

1—The Federal-State, or Federal Aid Highway System, approximately	200,347 miles
2—County, Township and other public roads	2,661,850 miles
Total	2,862,197 miles

In contrast with the railway transport system with its centralized operating agency and close working alliance with the general public through the Interstate and State railway commissions, the highway system is operated by a vast unwieldy body of unrelated organizations with continually changing personnel, and except for a relatively small portion of the total mileage, where the duties have been delegated to competent persons, there is only fragmentary knowledge of the economic problems with which these highway authorities are confronted. It

is not surprising, therefore, that staggering sums of public funds are being wasted annually on the highways and that an enormous number of unnecessary accidents and casualties occur. These casualties would be greatly reduced if coordinated control of these political subdivisions were set up and the highway transport system coordinated and modeled, as far as practical, on the system which the public has built up for its railway transportation system.

Many Highways Are Unnecessary

Over night, as it were, the horse-drawn vehicle has practically disappeared from the highways, to be replaced by the self-propelled vehicle of from five to twenty times the weight and three to ten times greater speed, and with maximum passenger and freight carrying capacities equivalent to railway coaches and freight cars.

This rapid change has made possible such great changes in highway transport as to render unnecessary and undesirable a vast highway mileage of the horse-drawn vehicle age which now constitutes an enormous drain on the public treasury and an ever increasing burden for upkeep as well as outstanding menace to public safety. Their continuation is an economic public liability.

It has been stated by a prominent highway authority that with proper education and scientific planning approximately 30% of the county, township and miscellaneous highways would be unnecessary, and their abolition would reduce proportionately the number of existing highway intersections and railway crossings, and operate in turn to decrease the annual cost of maintenance with its excess burden of taxation, and what is more, decrease the annual toll of lives and casualties at grade crossings. A partial study in several western States seems fully to justify this statement.

Useless Roads Cause Heavy Tax Burden

Our system of indirect taxation makes it very difficult for the average citizen to realize how much better off he would be financially if this great burden of unnecessary highways with its incubus, the dangerous grade crossing were taken from his back and the highway system properly correlated between trunk and feeder lines, unnecessary branches being lopped off wherever their economic necessity cannot be shown. But the application of this principle will first require proper recognition of the economic advantage of properly correlated national railway, highway and water transport systems and relieve multitudinous highway bodies of their authority on standardization, maintenance and operation. This work should be delegated to a properly qualified state authority functioning through state utility commissions, who, in turn, should be required to work through a national authority associated with the Interstate Commerce Commission with respect to public policy in the production of safe and convenient highway transportation.

New Organization Proposed

It is a matter for serious consideration whether federal highway aid should not be withheld until some satisfactory organization of this character has been properly developed by the states.

One of the practical results that this would doubtless accomplish would be to require a clearer and more comprehensive understanding of the strategic location and development for through trunk highways, and their relationship with secondary or feeder roads than now exists; as well as a more rational authority for their projection from federal and state sources.

The more important secondary feeder lines would thus become tributary in fact to the trunk road, and bear the same relation that a feeder does to the main line of a railroad. What is equally important, it would permit the prompt closing of branch roads and railway crossings as they become unnecessary through the development of the highway system, in much the same manner as branch line mileage is treated on the steam roads. With the railway, when their public necessity has ceased, such branches are torn up and not permitted to remain as a liability on the main system, whereas, with relatively few exceptions, the unnecessary branch highway liabilities continue.

Should Be Based on Thorough Study

The public has already expended enormous sums for the new and improved thoroughfares with vastly increased hauling and speed capacities, making distances no longer the comparable factor that they were heretofore.

Our unrelated highway system divides into three groups:

Group 1—Municipal streets and park roads.

Group 2—Interstate or federal-state trunk highways.

Group 3—County, township and miscellaneous roads; and as previously shown, controlled by unrelated political

subdivisions with a large mileage in Group 1 and Group 3 rendered unnecessary by the development and improvement of the highways in Group 2. It is on the latter group that federal and state highway funds have been principally expended.

It is apparent, therefore, that the federal-state roads of Group 2, with suitable secondary or feeder connections from Group 1 and Group 3, constitute the essence of the public highway system, to be fostered and developed as far as practicable in the same manner as the steam railway system has been developed in the same interest.

It is also in the collective interests of all parties that a thoroughly scientific study should be undertaken by a properly constituted national body working with the states, and the railway, highway and waterway interests, for the establishment of definite principles and methods for planning and developing a properly articulated national transport system.

The importance of this is further emphasized because of the close relationship of the highways to the railways and waterways. No such study has been undertaken in the newly developing highway system, for which the national and state treasuries are annually appropriating large sums of money. All three are being supported by the public at a staggering expense.

Crossings Continued on Obsolete Roads

A large mileage of these branch highways now obsolete through the building of the existing trunk system, carry their proportion of unnecessary grade crossings. These crossings are being continued although there is every reason why they should be closed; because through lack of correlation, definite planning, and in the absence of any central authority, there is usually an insistent local demand for their continuance, or for a grade separation, which would not be the case if there was better co-operation in locating the roads between these independent highway authorities and with mandatory authority lodged at some central source.

Grade separations are frequently compelled at such crossings because utility commissions, in many states, have no legal authority to close such highways, or compel suitable relocation, although aware that the public interest as a whole does not demand either the grade crossing or the separation. Utility commissions are usually unwilling to assume responsibility of continuing a crossing at grade, when its hazardous condition has been officially called to their attention, and are also not inclined to assume responsibility for modern forms of highway protection. As they have no jurisdiction over the federal, state or county highway authorities, a separation of grades on the unnecessary road is usually the easiest way out irrespective of the economic or financial problem involved; although it should be said in justice to some of the state utility commissions that this is not always the case.

Highway legislation in most states needs a thoroughgoing renovation to put it in step with modern conditions, a fact well known to most highway engineering authorities.

The Federal Government and the States have already paid more than $994,000,000 for the construction of about 50,000 miles of federal-state highways, and in the interest of the railways and the highways, as well as in the interests of public safety and public expenditures, the excess highway grade crossings thus rendered unnecessary should now be closed.

Remove Hazardous Crossings

This action should be immediately followed up by the removal of the extra hazardous grade crossings which now exist on every railway and are alike dangerous to the public, the highways and the railways.

In the interest of public safety some way should be found by state public utility commissions, through suitable legislation, if necessary, whereby state highway commissions will be required to give first preferred attention to such crossings, even though it reverses present policies of federal-state highway construction.

If plans of this character were carried out it would reduce the total number of existing grade crossings in the United States from approximately 250,000 to about 75,000, of which only 10,000 are on the main trunk or federal-state thoroughfares. It would save a vast army of human lives each year and reduce an appalling list of casualties as well as result in the saving of staggering sums now being expended by the public through the agency of the railways and the highways for the maintenance of unnecessary grade crossings.

The present planning of federal-state highway roads in practically every state

bears absolutely no relation to these hazardous crossings, and railway funds otherwise available for aid in grade crossing elimination are thus diverted by the action of state highway commissions to crossings which bear little or no relation to the existing extra hazardous crossings.

The federal-state highway system is being planned and developed without proper co-ordination with the railway system, and as the laws under which the federal and state highway commissions are organized do not require state highway commissions to be conversant with requirements in steam railway transport, it is not altogether surprising that with all of the money being paid out for grade crossing elimination, there still continues to be a heavy loss of life and unnecessary accidents at extra-hazardous grade crossings, which would otherwise have been given preference by railways in elimination programs.

Uniformity of Protection Needed

There is also urgent need for agreement between public authorities and the transport system for uniformity in the protection of the less hazardous grade crossings and intersections. These crossings constitute by far the greatest percentage of the total grade crossings and have the greatest potential hazard for the public. A proper understanding of this problem is of first importance, to be followed up by scientific treatment along modern lines and consistent with public safety requirements.

It is easily the greatest menace and correspondingly the greatest safety measure before the public, yet, strange to say, it is little understood by many public authorities in the light of modern necessities. Highway bodies and commissions often fail to appreciate why manually operated protection is now so frequently found insufficient and unsafe to cope with modern conditions. Automatic forms (known as automatic flagmen) requiring compulsory contributory action by the highway user with a uniformity of types and use, are recognized by experts as being the best and surest means of public education.

It would seem that the accomplishment of this objective is so essentially in the public interest that its importance need not be further dwelt upon, but until the railways can deal with a national public authority with sufficient jurisdiction, this menace seems destined to continue.

Number of Crossings Increases

Highway legislation of former days is not in step with modern conditions of transport necessities, with the result that while vast sums of money are being expended annually for grade crossing elimination, yet the number of grade crossings continues to increase each year by official sanction irrespective of the almost criminal hazard and liability thus created.

Some eastern states do not permit their public authorities to create additional grade crossings. In states where this is in effect for a number of years, it has been found to bring about excellent results.

With a properly articulated system of trunk and feeder roads, very few additional crossings are necessary. If such crossings were required to be separated in the first instance and the costs apportioned by assessment against the property and interests benefitted, there would be a remarkable decrease in this agitation. Meanwhile, state public utility commissions and other similar authorities would be relieved from the necessity of either creating the hazard or offending their constituents.

Vehicle Operators Are Not Under Control

The self-propelled machines operating on the railways and on the highways are now equivalent in capacity for speed, and necessarily require the same character of systematic skilled examination, supervision, and control. The railways provide this. Their enginemen who operate the locomotives are advanced to that position only after long years of training and experience and always thereafter with continuing checks on eyesight, discipline, habits and mental alertness. These men have behind them established records for carefulness and with reputations for safe operation to maintain. They are in turn supported by a staff of mechanical experts and supervisors with facilities for thoroughgoing examinations of their machines after every trip, and backed up by stringent national safety appliance laws with federal inspectors to see that they are enforced. No such provision can be made by national, state, county or municipal highway authorities because of divided responsibility, divergence of views, and defective legislation. It is only through public education that there will come laws and regulations which will compel modern legislation to replace the ancient moss-grown statutes of the horse-drawn-vehicle age with modern devices replacing present practices so that

comparable safe operation will be possible.

Roads Built With Public Funds

The federal-state trunk highway system now completed comprises 53,958 miles. The program for extension contemplates its development into 70,752 miles, and when finally completed 200,347 miles, with future possibilities for development under the existing law. These highways are being built parallel to and across the railway system whenever in the opinion of the state highway authorities it appears desirable. Many of these crossings are new and in addition to what formerly existed. In some cases the released crossings are closed, but as heretofore pointed out the net result is to increase rather than decrease the number of highway grade crossings.

Under the provisions of the federal law, to which reference has been previously made, the government has already expended $439,339,402 to aid in the construction of the federal-state highway system, and the state tax payers have expended $555,340,454.

Since 1916 the Government of the United States has entered upon a program of aiding in the construction of the principal trunk line mileage constituting national or federal-state highway systems.

The first highway act of Congress approved July 11, 1916, under the title, "an Act to provide that the United States shall aid the States in construction of rural post roads" (39 Stat. 355). In the first section it is provided:

"That the Secretary of Agriculture is authorized to co-operate with the States through their respective State Highway Departments in the construction of rural post roads; but no money apportioned under this Act shall be expended until the Legislature shall have assented to the provisions of this Act . . ."

The passage of this law resulted in the creation of the Federal Bureau of Roads and the organization of State Highway Commissions in the several states. These were charged with the duty of building the federal-state highways in conformity with the provisions of the act.

Give Bureau of Public Roads More Power

The functions of the Bureau of Public Roads are limited by this act and largely devoted to the apportionment of federal appropriations to the states in the manner prescribed by law. Unfortunately the bureau does not have sufficient or proper authority under this law to regulate standard practices. Beyond this their functions are largely of an advisory and administrative character.

The Bureau is admirably organized and administered. It is composed of well trained engineers qualified in the science and art of highway construction and it is unfortunate for the general public that the law does not give them sufficient power or authority to insist upon uniform standards for construction and maintenance. In the interest of public safety and convenience, the power and authority of this bureau should be enlarged along lines similar to the Engineering Corps of the United States Army. It should be taken from the Department of Agriculture, where it does not belong, and placed under the Interstate Commerce Commission or under the Department of Commerce, depending upon how the organization is affected.

While the state laws creating the highway commissions of the several states differ materially, their principal function is substantially the construction and maintenance of the federal-state highway system, which, as stated, constitutes a very small part of the state highways. They have little or no jurisdiction over the remaining state highways. They are largely political in character, but fortunately, through provisions of federal requirements, the expenditures are made through a competent body of state engineers well qualified for their duties, and their jurisdiction should be extended over the highways in their respective states with respect to construction, maintenance, highway marking, and standard practices, also working in close alliance with the Federal Bureau of Public Roads.

Place State Roads Under Public Utility Commission

As the federal and state laws of all the states now vest control of the principal transport agencies in their respective public utility commissions, it is difficult to see why a duplicating body in the shape of a state highway commission with independent authority should also exist. Simplicity of administration and public safety would be greatly advanced if the commissions were abolished and the administrative functions performed under the state public utility commission to which the state bureau of highway engineering might well report. A change of this character would be an outstand-

ing advantage in the advance in the administration of the public highway system. For the same reason it follows that the jurisdiction of the public utility commissions should also be extended over county, township and municipal roads, insofar as they affect safe and convenient public operation, and placing the control of railway grade crossing and highway intersections solely within their jurisdiction, similar to the Illinois law which places the control of all grade crossings in the state within the jurisdiction of its Commerce (Public Utility) Commission. This arrangement would permit utility commissions to extend the jurisdiction of their expert transportation staffs (now functioning for railway or water transport) so as to include intrastate highway and waterway transport as well.

Division of Cost Is Difficult Matter

The greatest stumbling block in the way of an orderly program for the elimination and protection of unnecessary highway grade crossings is the lack of common understanding on the part of the parties immediately concerned regarding the apportionment of cost for the changes. It may be said at once that there is little doubt but that the railways would look with favor upon some systematic and orderly program of grade crossing elimination if the costs were equitably apportioned with due consideration to existing extra hazardous crossings and the closing of unnecessary crossings, recognizing meanwhile that a proper development in the highway system may frequently mean the crossing of the railways at points where no crossing at present exists, or the occasional selection of a crossing which at the time may not be one of the particularly burdensome crossings in the affected area. All these problems are susceptible of solution in the interests of the general public when there is a better understanding on the part of all concerned, of the economic and safety aspects of the grade crossing problem.

The federal Bureau of Public Roads has outlined some admirable provisions with respect to grade separation. It considers that while ultimate elimination is the final solution, it is, after all, an economic and financial problem, in which the more dangerous crossings on the federal-state highway system should be first considered, and apparently recognizes in principle the fact that there are many extra hazardous crossings on the several railroads which are not on the federal-aid thoroughfares, concerning which the railroads must deal with state, county, municipal or other public bodies, and to which railway funds must also be allocated, but as the Bureau is concerned, under the law, with aiding in the construction of what is in effect the national highway system, the government is directly interested in the elimination of the more dangerous crossings created thereby.

Federal law has clearly anticipated this in Section 2 of Act of Congress previously mentioned, and provide, among other things:

> "That for the purpose of this Act the term 'rural post road' shall be construed to mean any public road over which the United States mails now are or may hereafter be transported excluding every street and road in a place having a population, as shown by the latest available Federal census, of two thousand five hundred or more, except that portion of any such street or road along which the houses average more than two hundred feet apart; . . . necessary bridges and culverts shall be deemed parts of the respective roads covered by the provisions of this Act."

In making appropriations for the Post Office Department for the fiscal year ending June 30, 1923, and for other purposes, Congress further provided:

"For the purposes of this section and of the acts heretofore making appropriations to aid the States in the construction of rural post roads the term 'bridges' includes railroad grade separations, whether by means of overhead or underpass crossings." (42 Stat. 660.)

Also by Section 8 in Regulation 6 of the "Rules and Regulations of the Secretary of Agriculture for Carrying Out the Federal Railway Act" it is stated:

"Grade crossings occurring on the Federal Aid Highway System shall be classified for priority of improvement by agreement between the State Highways Departments and the Bureau of Public Roads."

It will be seen from the foregoing that it is clearly the purpose of Congress to aid in the elimination of the grade crossing hazard which the construction of the Federal Aid System of roads must necessarily encourage. The federal act was originally passed as a rider to the Agriculture Bill and shows evidence of being somewhat hastily drawn and in the light

of its practical application is loosely worded and susceptible of various interpretations. This fact has permitted a number of state highway commissions to nullify the clear intent of Congress and apply the federal funds that should otherwise be spent on grade separations for the construction of additional highways elsewhere in the state and by taking advantage of state laws passed during the horse-drawn-vehicle age they seek to compel the railways to assume a far greater portion of the expense than can be reasonably justified. This is not surprising because, as previously stated, state highway commissions have no responsible connection with the public for providing necessary safe and convenient railway transport.

The railways on the other hand believe that there is no difference in principle between withholding the federal aid from a federal-state highway grade separation project, so that the money might be expended elsewhere in the construction of roads, thereby exacting from the railroads that amount of money which would be equivalent to federal aid, and taking the railway's moneys for constructing highways elsewhere in the State.

Railroads Must Deal with Many Local Bodies

Meanwhile the railways are called upon to deal with other highway bodies in cities on their problems of grade separation or track elevation, and again with county and other bodies on crossing eliminations over which neither the municipal nor the state highway commission has jurisdiction, each applying different reasonings and formulas, and none of them directly concerned with its effect on public transport service by the railways. It is not surprising, therefore, that controversy results and essential grade separations are unduly delayed, and often unsatisfactorily executed in the interests of the public when finally undertaken.

Arbitrary Assessment of Cost is Wrong

It is a well developed principle of economics and in harmony with sound business methods that apportionments of cost for public improvements of this and like character should be apportioned on the basis of the benefits received, but it is very difficult in some states to get state highway commissions or other highway authorities to concur in this principle. A railroad is benefited by a separation of grade wherever its presence enhances the danger of a grade crossing to the extent and degree of danger which its presence creates, and no more. In other words, an arbitrary assessment irrespective of the benefits received is wrong in principle and contrary to the spirit of the common law. Federal and State laws relating to appropriations for highway construction should be so amended as to require a fixed portion to be available only for grade separation projects. By so doing it would remove the apparently irresistible temptation from state highway authorities to please their constituents by construction of additional highways while leaving the general public to be injured and killed at hazardous or extra-hazardous grade crossings which otherwise might be abolished. Until some action of this kind is written into the statutes, public safety at railroad crossings must remain largely a matter of policing by the railroads with such assistance from local communities as their officers may, for the time being, persuade them to give, until the state highway commissions, in the state where such ruling prevails, can be brought to realize that grade crossing elimination will be greatly accelerated on the federal-state highways, and public safety and convenience enormously advanced by enlisting co-operation with all the affected interests in such a way that the apportionment of costs will be equitably spread. Also that this is much more to be desired than the building of a few more highways.

The same principle, of course, applies in the apportionment of cost to the protection of a vast number of hazardous and other crossings where highway protection is necessary. Changed conditions of public travel require that where the hazard is sufficiently great the public will be protected and that the costs should be apportioned on the basis of the benefits received alike by the user of the highway and the user of the railway and other political subdivisions or interests benefited so far as their interests can be shown. An application of this principle would permit better and safer protection than is now possible when public authorities undertake to saddle the expense on a single interest and divert the tax funds collected for safe and proper maintenance to other purposes.

General Plan Would Avoid Unnecessary Separations

State utility commissions have concurrent jurisdiction with the Interstate

Commerce Commission over the railroads in their respective states but they have no jurisdiction over state highway commissions who are the nearest approach in the several states to controlling the highways of their states. Although the Utility Commissions may give or withhold the authority for the creation of additional grade crossings, they have no authority to alter, amend or change programs of the state highway commissions with respect to this as pertains to highways or highway crossings, even though by so doing the railroads or public interests may require such alterations, amendments or changes. As a result, the railroads are frequently called upon to appropriate funds for the elimination of grade crossings which later may be rendered unnecessary and would be avoided if some central authority interested in the railroads and the highways were in a position to enforce a plan of highway construction. The same thing applies with equal or greater force to the lesser political divisions in the shape of county roads.

It will be seen from the foregoing that highway grade crossing protection or elimination is a national question and that the public is interested through its control of the railroads on the one hand and the highways on the other hand. Also that the federal government is equally interested because of its control over interstate transportation. Various other agencies are equally interested, for example, the bus or truck lines operating for hire, or other interests including the railroads as the facts may develop.

The appropriation of cost should be on the basis of benefits received, both with respect to elimination and crossing protection, with standard practices adopted which will represent the best and most economical forms of construction and maintenance throughout.

If this is worked out with proper legislation incident thereto, it will result in the development of a plan for the elimination of dangerous crossings, meanwhile protecting the remaining highways of lesser importance by standard marking so that the public will become accustomed to them, which will result in the lessening of the daily loss of life and the unnecessary costs incident thereto, meanwhile permitting both transportation systems better to understand the workings of one another and their relations with the public, a fact which is impossible under the present conditions.

A. A. E. TO FIGHT "ENGINEER FACTORIES"

Severe criticism was directed at correspondence schools whose courses are obsolete, and advertisements and literature misleading and full of false promises, at the 13th annual convention of the American Association of Engineers held at Tulsa, Oklahoma, on June 6-9, Trade schools advertising to make "full-fledged" engineers after a few weeks' training in their shops equipped with out-of-date, home-made machinery and equipment, also received an equally severe scoring from the engineers, who voted to continue the campaign to force the fake schools to modernize their courses and training or else be put out of business.

Pitiless publicity is to be the weapon with which the engineers plan to fight these "engineer factories." While they recognize efforts of the Federal Trade Commission, National Home Study Council, made up of some of the reputable correspondence schools, and the Better Business Bureaus, all of which are doing good work in cleaning up the correspondence and trade school industries, the engineers decided that the spotlight of publicity will be the most effective weapon with which to put a stop to the "graduation of half-baked engineers," who are thus foisted upon the public and damage the engineering profession.

The condemnation of questionable correspondence and trade schools followed reading and approval of the report of H. A. Wagner, chairman of the association's national correspondence school committee, which has been making an extended survey of these schools. Mr. Wagner has gathered a wealth of information and data about these two little known industries.

Some of the high points of their development came as a surprise to the engineers. Few knew that in them were enrolled four times as many students as are in attendance at all of our colleges, universities and institutions of higher education. Nor did they realize that at least 80 per cent of the 300 and more correspondence schools were privately owned or controlled. The report shows that there are in the correspondence school game, stock companies capitalized as high as $10,000,000 and having a staff of over 3,000, including sales force.

Other high points in the report are that the number of active students in correspondence schools, range from 100,-

000 to 225,000 men and women, and that over 200 subjects are taught, from accountancy to wrestling.

"There are so-called universities and correspondence schools that teach chiropractic, play writing and dentistry in twelve lessons and award the degree of "Doctor of Philosophy" all for $8.50, cash in advance," reads the report.

It is asserted further than the cost of advertising and follow-up letters to secure students costs from $10 to $30 per student and that the schools spend from one-fourth to one-third of the tuition fees collected to pay for their advertising appearing in newspapers, trade journals and magazines.

Country towns of 2,500 population and under furnish most of the students for correspondence schools, Mr. Wagner finds, and the Pacific and mountainous sections of the United States show the largest percentage of enrollments. The volume of business done annually is estimated at $80,000,000, a figure which surprises those who have given little, if any attention to this educational activity.

But the portion of the committee's report most interesting, is that devoted to the tricks being worked on the public by the questionable schools. The committee states that practically all of the correspondence schools offering technical training have been investigated, and with schools of this class, the report is most concerned. It is charged that a majority of these schools investigated are indulged in misleading advertising.

"Prospective students are promised everything," says the report, "from positions paying $10,000 a year, to job guarantees. They paint a very alluring picture of what you get for $100 a course or more, payable at the rate of $5 a week or month. Educational standards of the various schools are such that many of them are offering obsolete courses, written fifteen years ago and never revised. The lessons in many cases are poorly written and are nothing but technical drool. The follow-up letters and literature are the most wicked tools for inveigling unsuspecting prospects."

Some trade schools which have had a mushroom growth in large cities in the last few years are designated in the report as "a crying evil in the technical education field."

"These schools undertake to make an engineer out of anyone who has the price within a short space from three to six months," says the report. They make no selection from among students and enroll everyone who applies and it makes no difference to them whether or not the prospective student has any education or even speaks the English language."

The committee's investigation of trade schools, and especially those in Chicago, disclosed that some of them solicited and enrolled Nez Perz, Yaqui and Cherokee Indians, cow punchers and others, equally unsuited to ever become engineers.

"Some of these Indians and cowboys had never seen a school," continues the report. Some of them could not speak the English language, and the great majority of the white men who came to the association's office in Chicago had not gone beyond the fourth grade in school, but all had put up several hundred dollars to become engineers. Chicago's charitable institutions have handled any number of cases of "destitution," due to these trade schools that cheerfully appropriate the last dime from their victims. The committee has been successful in securing refunds for some of the Indians and cowboys who had been persuaded to come to Chicago by some of these trade schools.

"The trade schools investigated present a sorry spectacle. Their equipment is generally obsolete and most of it used in elementary work is a joke, being home-made and by parties who evidently never have known the use of tools. There is no chance for any young man, even with a good preliminary education, to get anywhere near his money's worth out of such a course. In short, the great majority of trade schools are in existence solely for the purpose of obtaining money under false pretenses."

In the opinion of the committee, it behooves the engineering profession to arouse itself to the dangers arising from certain types of correspondence and trade schools turning out "half-baked" engineers.

"The effect of misleading correspondence and trade schools on the compensation of engineers is obvious," continues the report. "Daily there comes to our employment department at headquarters in Chicago, men who exhibit diplomas from some sucker school, who expect to obtain immediate employment as draftsmen or engineers. Frequently such men have had no previous engineering training or practical experience. The most deplorable thing about it all, is that they generally state they are willing to work

for little or nothing in the beginning to get a start.

"You can readily understand what such competition must mean to the young engineer just out of college, and you can see, furthermore, the impression an employer gets of the engineer and engineering profession as a whole, when he comes in contact with these 'half-baked' engineers."

While condemning the practices of disreputable correspondence and trade schools, the committee goes on record as approving the principle and idea of home study and states that properly conducted schools offering such, fill a necessary place in our educational system. It further urges that some means should be devised to increase interest in home study courses, and some drastic changes are suggested in the conduct of both correspondence and trade schools.

These refer particularly to the form of contracts under which the training and courses are sold. At present, the student enrolling signs a contract for the full amount of the course, such contract generally being unbreakable, even though the student finds he is not fitted to continue the course in which he has enrolled. In the collection of such contracts, the committee finds, serious abuses are committed by the fake schools.

The committee recommends that corresponednce schools sell their courses by the lesson, so that a student finding himself unfitted in education for the course, can pay for the lessons used and end the course. In the case of trade schools, the committee suggests that when any student discovers his education has not been sufficient to continue and finish the course,, he can have his tuition fee refunded on a pro rata basis, thus reimbursing the school for the time and lessons consumed.

Sale of courses and training along the above suggested lines, in the opinion of the committee, will have a salutary effect, for it would put out of business the fake schools which have been fattening off the lapsed courses which they have forced students to pay for through the medium of their own collection agencies, masquerading under different names. Reputable schools with their worth while courses and care in acceptance of students who have the capacity to complete such courses, will be able to hold their students in the opinion of the committee, and the flood of abuses arising out of prosecution and persecution of lapsed students will automatically disappear and the industry would rise to high business standards.

Editors and publishers of newspapers and magazines have signified their desire to co-operate in putting the fake schools out of business, the report states, to the end that misleading advertising be eliminated and educational standards improved. Presidents and deans of engineering colleges are also reported to be 100 per cent for the movement which it is expected will raise educational standards and especially engineering courses and the engineering profession.

IMPROVED ROADS OF LOW COST

By C. N. Conner, Highway Research Board, Washington, D. C.

(From a progress report presented at 6th annual meeting of the Highway Research Board.)

The object of the investigation is to collect, correlate and present information in order that conclusions may be drawn and comparisons made on types, costs, traffic capacity and suitability of intermediate type road surfaces under varying conditions of soil and climate.

It is not the intention to make it highly technical in character or to delve deeply into the mechanics and chemistry of aggregates and admixtures, but rather to make a wide general survey of conditions as they exist in actual field practice or experimental sections.

The scope of the survey includes:

1. Treatments and surfacing of loam, clay, top soil, sand clay, marl, lime rock, sand, cinders, slag, gravel and stone;

2. The admixtures for these treatments include lime, calcium chloride and other chemicals or by-products, road oils and asphalts, tar and Portland cement;

3. The climatic conditions include those of the southern, middle and northern states as well as some of the more arid regions;

4. The types of surfacing will include chemical soil treatments, hot and cold surface treatments with tar, hot and cold surface treatments with asphalts, surface treated and penetration macadams, modified sheet or sand asphalt. using local materials, bituminous concrete, using local materials, natural rock, asphalts, portland cement and local sand mixtures.

These types of surfacing will be con-

sidered in connection with the different types of base on which they have been used, but will not include standard base courses of portland cement concrete, plain and reinforced concrete.

Field inspections have been made during parts of July, August, September, and October, 1926, in the states of Maine, New Hampshire, Vermont, Rhode Island, in Long Island, New York, New Jersey, North Carolina and Virginia.

It was gratifying to learn and observe the success which has followed the necessity of furnishing highway surfaces at a comparatively low cost. This, naturally, has been accomplished to a large extent by using local materials.

The types inspected included calcium chloride treatments of gravel, asphaltic oil treatments of gravel, tar treatments of gravel, asphaltic concrete on gravel or stone base, sheet asphalt on gravel or stone base, bituminous macadam on gravel or stone, marl base with tar surface treatment, marl base with sand asphalt top, and sand asphalt.

Other types of surfacing have been studied but not investigated in the field, such as the oil-bound surfacing of stone roads, lime and portland cement treatments of clay and portland cement mixtures with local sand.

Lime Treatments of Earth Roads

The principal tests to determine the effect of treating earth roads with lime were conducted by the Engineering Experiment Station at the University of Missouri beginning in 1924, about the same time field tests were started by the U. S. Bureau of Public Roads in Iowa and South Dakota. Since that time Ohio State University, University of Illinois, and Wisconsin State Highway Department have entered the investigation, each with a particular problem.

This investigation has consisted of laboratory work, together with actual field tests, and while the experiments are not yet completed, several things have been discovered which might be of interest here.

In making the lime treatment hydrated lime is thoroughly mixed into the road soil to a depth of 6 in. by plowing and discing. To obtain the best results the road should be quite dry when the treatment is made, in order to get an intimate mixture. The road is then dragged to the proper cross section and opened to traffic which quickly packs it.

It is stated that lime treatment stabilizes heavy clay and silt soils. These soils lose their stickiness and plasticity, becoming granular in structure, which renders them capable of sustaining normal traffic loads without failure when wet.

The field tests with lime treatment have used various percentages of hydrated lime ranging from 2 to 5 per cent by weight and from 3 to 9 per cent by volume. The depths of soil treatment have ranged from 2 to 6 in. with the majority of them at 6 in.

Among the possibilities looked for in these tests are:

Where traffic is heavy enough to warrant a better road, the subgrade may be treated with lime and the surface covered with a thin layer of crushed stone or gravel. Without the lime this thin layer of surfacing material would soon sink into the clay and disappear; but with the increase in stability and loss of plasticity due to the effect of the lime, the thin layer of gravel or crushed stone is expected to remain on top.

It is claimed that maintenance on a lime treated road is simplified in several ways. The soil loses its stickiness and is not picked up by the wheels of vehicles. This keeps the road from becoming rough. The increased stability of the soil prevents the wheels of vehicles from cutting ruts after the surface begins to dry. The lime treated road dries out faster and can be dragged many hours sooner than the road without lime. The treated soil mulches more easily under the drag, making it easier to obtain a smooth riding surface.

But whether or not these treatments are to become an economic success in competition with local sand and gravel as surface stabilizers has not been proved from the results so far obtained.

Calcium Chloride Treatments

In many states and localities where local gravel, sand, clay, or top soil are available a large mileage of surfacing has been constructed, but due to the intensity of traffic in summer and dry weather the dust nuisance has become a serious menace.

As is well known, when traffic reaches 300 to 500 vehicles per day the surface often becomes corrugated and an appreciable amount of surfacing material is lost.

Insufficient funds to lay a hard surface highway or even oil or tar treatments have forced these localities to find a palliative in order to carry their summer traffic.

In New England both Vermont and Maine have used this material with a reasonable amount of success for the purpose intended.

During 1925 Vermont treated over 2,200 miles of gravel road and Maine has about 500 miles.

The amount of calcium chloride applied per year varies between ½ and 1½ lb. per square yard in these states and is applied from a lime spreader hauled by a truck. Other trucks are put in use to bring up additional supplies as the work progresses.

It has been found that dust and corrugations are reduced but that pot holes will occur, which may be remedied by patching with fresh gravel.

The calcium penetrates as deep as 1 in. in places, in others scarcely at all. This variation is due to the porosity of the surface material and amount of calcium chloride applied.

The opinion in Vermont is that the gravel should contain a fair amount of binder, say, up to about 25 per cent.

These treatments do not effectively carry through the winter; however, there is a slight evidence that some benefit exists in the following spring from the previous season's treatment.

The total costs per mile per year seem to vary between $100 and $300, the variation being due to the porosity of the soil, intensity of traffic and amount of applied chloride. The cost of application in Vermont is 17 per cent of the cost of the delivered material.

The final report will contain data from other states including Michigan and Minnesota where it is understood these roads are carrying 1,000 to 3,000 vehicles per day.

Sand-Oil Surfacing or Sand Asphalt Layer Method

Although this type of surfacing has been satisfactorily used in Long Island, New York, for at least 10 years, it is only within the past few years that its possibilities for similar soil conditions in other localities have become apparent.

We now find this or a similar surfacing being tried out in actual service in several of the southern, middle, and far western states.

Its economy and success depend largely upon the proper selection and manipulation of the local materials, as well as performing the construction and maintenance under suitable weather conditions.

The surfacing in Long Island consists of a mixture of road oil; (Texas 55) mixed in place by dragging and traffic with local sand or sand loam, after successive applications of the oil and aggregate.

As a result of a field survey on some 400 miles of this work in Long Island a few observations will be made in this report:

The subgrades were in general sandy loam over sand or fine gravel.

Local materials as aggregates were used entirely.

The surfacing widths varied from 9 to 75 ft.

The thickness of mixed surfacing varied from ½ in. to nearly 6 in.

Crown ranged between ¼ and 1 in. to the foot.

Wider sections showed less fatigue than the narrow ones.

Two treatments are necessary the first year for satisfactory results.

One treatment each succeeding year is in general sufficient.

Some of these roads it is estimated are carrying as high as 5,000 and 6,000 vehicles per day in the summer season.

These surfacings are said to cost from $800 to $1,500 per mile for the first year using an 18-ft. width and from $300 to $800 for each succeeding year.

In many cases the surfacing is protected during the winter months by pulling in sand and loam from the ditches to a depth of about ½ in. over the entire surface. This is done at the beginning of cold weather, usually in October.

It must be borne in mind that the local material as found in Long Island is well adapted to this type of construction.

Beginning in 1924 oil treatments of gravel roads were started in New Jersey.

The same grade of oil is being used and similar methods of construction and maintenance are being employed as in Long Island.

Good aggregates for cover material are easily procurable locally.

Inasmuch as skill in construction and maintenance are not as highly developed on this particular type in New Jersey the results at present are not as gratifying as in Long Island.

There is every reason to believe that this sand-oil type will be satisfactorily developed as the local materials are excellent.

The costs in New Jersey are about the same as in Long Island.

This same type of construction was

started in North Carolina in 1925 after some experimenting in 1924.

The oil treatments were applied to sand clay, top soil and gravel roads.

At first oil was used for the prime coat and following treatments. This was later changed to a prime treatment of tar followed by a quick curing asphaltic oil.

Something over 400 miles of this work have been constructed in that state.

The results in general have been very satisfactory especially as to improvement in smoothness of riding surface, increase in traffic-carrying capacity at all seasons and abolishment of dust.

Some of this work cost as high as $2,500 per mile for a treated width of surface of between 18 and 21 ft. for the first year.

It is very probable that the cost can and will be reduced for succeeding years to about $700 per mile on surface previously treated.

These treatments were not entirely satisfactory on certain sand clays, on worn-out fine gravels and in places where the cover sand contained undesirable foreign elements.

It is probable that these roads will satisfactorily carry from 1,000 to 1,500 vehicles per day and possibly more.

The sand-oil or gravel-oil road has been tried out in other states and in Mexico with varying degrees of success and there is great probability that, with careful study and intelligent selection of local materials as well as proper construction and maintenance, the sand-oil road will become much improved in the next few years.

Tar Treatments of Gravel

In Maine, New Hampshire, Maryland, Virginia, Wisconsin, Michigan, and several other states, the use of tar on gravel roads has met with considerable success.

As in the case of the oils, the most successful results have been achieved when great care was taken in the selection and preparation of the surfaces to be treated, as well as care and pains in the construction and maintenance.

Forced by the necessity of carrying its own traffic and that of a large tourist traffic in the summer months, Maine was probably the first state to make a success of tar-treated gravel surfaces. After many of the details and methods had become established, other states took up this method of tar treatments of gravel.

There are about 550 miles of tar-treated gravel roads in Maine whose climatic conditions are probably as severe as any state in the Union.

Depending on weather and traffic these roads at times break up in the fall or winter of each year. This breaking occurs at a period of thawing on warm days following a period of freezing weather.

In Maine, it is the policy to scarify and reshape these surfaces each year. The old tar mat, however, is not wasted but is broken up and spread again over the gravel surface, compacted by traffic or rolled and then retreated with tar.

On account of the heavy freezing and poor subgrades, a sub-base of from 2 in. to 12 in. of gravel or stone is laid before the standard gravel surfacing is placed. Gravel sub-base is quite generally and satisfactorily used in New England under all types of surfacing, including portland cement concrete.

The gravel surfacing proper has a compacted thickness of from 8 to 11 in. The tar mat has a thickness of from ¼ to 1 in.

The tar surfacing complete costs in Maine, for an average of 17-ft. width of surface, from $800 to $1,500 per mile per year, the average being about $1,100.

This includes considerable patching, which is done by mixing coarse sand or fine gravel with tar either by hand or in a small power concrete mixer, hauling and placing as required.

The annual scarifying and reshaping process results in a comfortable and smooth-riding surface.

The methods in New Hampshire are similar to those in Maine except for the annual clarifying. While this is done to some extent it is not followed as extensively as in Maine.

The annual cost per mile in New Hampshire is about the same as in Maine on the same type of construction.

New Hampshire has about 1,000 miles of this type of surfacing.

Virginia has and is constructing tar-treated gravel roads. The surface treatments are costing from $1,100 to $1,500 per year for the first year.

Details from other localities are not available for this report, the final report, however, will include them.

Veneer Bituminous Macadam

It is somewhat difficult at times to

classify the various low-cost roads by name, but at the risk of being misunderstood the next type to be considered will be the veneer bituminous macadam.

This type of surfacing consists of a layer of crushed stone placed upon and keyed by rolling into the surface of a sand clay, top soil, or gravel roadway.

It is then penetrated with bituminous material and completed in practically the same manner as a penetration macadam surface.

An experimental stretch of this was laid near Raleigh, N. C., more than three years ago and is still rendering good service with a traffic of about 1,400 vehicles per day.

Another road of practically the same type was laid near Richmond, Va.

The first cost is about the same as for bituminous macadam surface; the annual costs have been about the same as for bituminous macadam under equal traffic.

A similar type of construction was completed in Oregon. The roads to be surfaced consisted of old water bound and also traffic bound gravel or crushed stone. It was found that the ordinary methods of maintenance were not sufficient to hold the surface intact and free from corrugations.

After experimenting for a number of years with clay binders the Oregon engineers developed the method of incorporating the binder with the surfacing material of crushed stone or crushed gravel by the process of thoroughly mixing the proper proportion of carefully selected binder with the stone or gravel by means of heavy blade road machines which mixed the material thoroughly.

In most cases water was applied by means of sprinkling trucks so that the resulting surface was really a stone clay or gravel clay roadway veneer.

The blading and traffic made this into a dense hard surface. After this surface had been maintained under traffic it was wet down with water trucks and the moistened surface shaved smooth and regular with a road machine.

It was then thoroughly cleaned of dust and oiled in two or more applications. About 0.3 gal. per square yard for the first and 0.2 gal. for the second.

It is stated that the total cost per mile 18 ft. wide for preparing and oiling these roads when in actual condition to receive the oil should not exceed $500 per mile.

With a normal amount of maintenance this road would probably carry 1,000 to 1,500 vehicles per day.

Retread Treatment

In line with this retreatment of old surfaces is the retread treatment as it has been called.

This consists of shaping and patching up the old road surface, placing on it a 2-in. layer of ¾-in. stone, smoothed out with a blader and treated with a ½ gal. per square yard of bitumen, then rolled if a roller is available. Traffic may be let over it, but if this is done the road should be bladed and dragged for from 3 to 5 days. This keeps the ruts filled and maintains a smooth and regular surface.

At the end of the fifth day, or when the surface begins to set up, blading is stopped.

The surface is again treated, this time with 0.3 gal. of the same material and covered with chips or coarse sand.

This method has not been investigated in the field, but if it is as satisfactory as claimed it should be of service in many communities.

In West Virginia the graded earth and shale surfaces are first surface treated with either road oil or tar, and then it is proposed to cover with stone passing the 1½-in. screen.

It is expected there will be some heaving and breaking during the winter when frost is coming out of the ground, where surfacing is thin and clay is abundant.

After the first year they propose to scarify the surface to the depth of the stone and then blade it to each side of the road in windrows. Between the windrows a new 2-in. layer of stone will be spread and penetrated as before. The two windrows will then be bladed back on this new layer and the same process of machining repeated as in the first year.

It is expected that the annual cost for a 16-ft. width of roadway will be between $2,000 and $3,000 and that by the end of the fourth year a good bituminous surface will have been built.

This and similar experimental construction on low-cost improved roads are attracting deserved attention.

In Pennsylvania the oil bound broken stone surface on stoned road consists of a surface course 2 in. thick after compression.

It is composed of ¾-in. stone, which

passes a 1¼-in. screen and is retained on a ⅝-in. screen.

The stone is dumped and spread, in accordance with standard specifications for macadam, into a smooth and regular surface on the old stone roadway.

It is then rolled with a 10-ton 3-wheel power roller.

Bitumen ranging from 0.3 to 0.4 gal. per square yard is applied and the surface rolled again to a uniform cross section and allowed to dry from 24 to 36 hours.

The second application of bitumen material is then applied at the rate of from 0.2 to 0.35 gal. per square yard.

Where a dull-brown color exists it is necessary to apply a larger amount of bituminous material than where an excess amount of bituminous material shows on the surface from the first application.

After the last application, the rolling is continued until the surface is thoroughly compacted.

"Rawhide" Surfacing

Among the patented types of surfacing is the "rawhide road."

The general principles of the type are similar in effect to the sand-oil roads.

The main difference is the employment of a special 10-ton tamping roller to mix and compact the soil and asphalt and in a short period of time rather than waiting for traffic to do the compacting.

The wearing surface is built up in successive layers by mixing the existing soil road surface with the applied asphalt until a compacted thickness of from 4 to 6 in. is obtained.

It is claimed that this road for an 18-ft. width can be built for from $5,000 to $10,000 per mile.

Marl and Lime Rock Base with Bituminous Surface

When local material of marl or lime rock are available a base course of 6 to 8 in. thick and covered with a bituminous surface has provided a low-cost improved road.

In some South Atlantic states deposits of these materials are found in close proximity to the road locations and can be more economically used as a base course than shipped in materials.

In southeastern North Carolina there is quite a large mileage of marl base.

This material is hauled from the pit, and the larger pieces screened out and crushed; all of the materials from some pits requires crushing.

It is then hauled to the road, suitably dumped, spread, machined with a blader, and firmly compacted by rolling.

Timber side forms on edge and equal in depth to base course, if set to line and grade, will aid in securing a better job.

Timber forms left in place where lumber is cheap have resulted in excellent work.

When the base has dried out the surface is finally trued up and cleaned. It is then ready for the bituminous surfacing.

In Florida there are three principal classes of local material used in this type of base course—Florida lime rock, ojus rock, and coquina rock.

Ninety per cent of the material is required to pass a 3½-in. screen and not less than 30 per cent retained on a ¾-in.

The specifications require temporary side forms, sprinkling, rolling, harrowing, and machining until the entire depth of crushed stone is bonded and compacted into a dense and unyielding surface true to grade and cross section.

These surfaces, after traffic has searched out the weak spots, are prepared and treated with various types of bituminous surfacing.

For lighter traffic a surface treatment of bituminous material and a coarse chip or coarse sand is used.

Another type is bituminous macadam, using hard crushed stone.

Asphaltic concrete using local materials has been satisfactorily employed, as has also sheet asphalt with a binder course.

Sand Asphalt and Bituminous Concrete, Using Local Materials

The coastal plain of the Atlantic seaboard does not have an appreciable amount of local hard rock, but in many instances it does have large areas of fine or coarse sand.

Massachusetts, in what is known as the Cape Cod section, took advantage of this fact some 15 years ago and started building bituminous concrete roads, using the local sands.

On account of the excellent drianage of the sand subgrades many of these older roadways are still entirely serviceable.

The earlier surfaces were laid 4 in. compacted thickness, but this method has now been changed to two courses of 2 in. each.

In the earlier pavements no side

DETROIT PUBLIC LIBRARY

forms were used, in recent years temporary side forms of 2x4 lumber are used for the top course.

The bituminous concrete is rather open and carries a low percentage of asphalt. It is considered necessary at times to ship in stone and filler dust.

After the first year these surfaces are treated with a light seal coat of road oil and sand.

At the present time these pavements are costing about $10,000 per mile for an 18-ft. width.

Some of these roads in Massachusetts are carrying as high as 2,500 vehicles per day.

The first sand asphalt pavement in North Carolina was constructed nearly five years ago.

It is similar in some features to the Massachusetts work on Cape Cod; the principal difference is the use of a much finer sand.

The 3-in. base course is composed entirely of local sand and asphalt.

The top course contains local sand asphalt and filler.

Side forms of cypress or pine are set on edge to line and grade, firmly staked and left in place.

The pavement as originally laid had a 3-in. base course and a 1½-in. top.

On account of some difficulties in cracking of top course and lack of band between top and base, some experimental sections were laid in 1925 and satisfactory results were obtained by making the following changes:

The surface of the 3-in. base was treated with a squeegee coat of hot asphalt immediately before placing the top and the top was increased in thickness from 1½ to 2 in.

Sand asphalt is now being laid in Delaware in the southern part of the state where large quantities of sand are available locally and where subgrade conditions are suitable.

Contract prices in North Carolina on this work have varied from about $1.40 to $1.90 per square yard, including side forms.

It is probable that this surface can be built for about $18,000 or less per mile for an 18-ft. width.

It will easily carry 1,500 to 2,000 vehicles per day.

Gravel Base and Stone Base with Bituminous Concrete and Sheet Asphalt Surface Courses

These all-year surfacings have given good service in widely separated sections of the United States.

From the field investigations so far it is evident that their traffic capacity has been exceeded near some of the larger centers of population.

This is more noticeable in the bituminous concrete than in the sheet asphalt.

The sheet asphalt is generally laid to a greater thickness and the binder course gives it greater stability by keying the top more securely to the gravel surface.

While these surfacings have been laid on newly constructed rolled gravel and stone surfaces, the better results have been obtained on surfaces which have been under traffic and maintenance for a considerable length of time.

In Rhode Island, bituminous concrete on gravel has been in service for six or seven years and possibly longer.

Like most of the other New England States, Rhode Island uses a sub-base or foundation course of pit-run gravel under nearly all of its surfacing. This varies in depth from a few inches up to 10 or 12 in.

On this sub-base course a 6-in. rolled gravel surface course is built, which in turn is covered with a 2-in. surface of hot-mix bituminous concrete. This bituminous top is made up largely of local sand and gravel. Two by 4-in. temporary side forms are used during the construction of the top.

The surface regularity is about the same as that of a good penetration macadam.

Average traffic on some of these roads is estimated at between 2,000 and 4,000 vehicles per day, with an estimated maximum of from 8,000 to 10,000.

The roads carrying the heaviest traffic, though still serviceable, show signs of fatigue as indicated by longitudinal, diagonal, and transverse cracks, also a continued depression or wide shallow rut near the edge of the pavement, caused by concentrated traffic.

A thickened edge of bituminous concrete would probably be advantageous.

Greater edge stability of this type of pavement has been secured by making the base course wider than the top course. This has been done on a large contract in California, in Massachusetts, and in other states.

In Michigan asphaltic concrete on gravel base is being built under careful

inspection, workmanship, and selection of materials.

They are using a base course extending 6 in. beyond each edge of the surface course, but without the thickened edge.

An extensive test on 12 different types of asphaltic concrete and rock asphalt surfaces on gravel will be conducted in Louisiana. Each test section will be 2,500 ft. long. This test will be watched with much interest and it is fully expected that definite conclusions can be made from the observations and results.

The investigation of low-cost improved roads has not progressed so far that conclusions can be drawn at this time between the relative merits of bituminous surfaces on gravel and on stone bases.

Some localities are getting good service with rock asphalts on gravel and stone base and at a reasonable cost.

Bituminous Macadam

It is very evident from inspections in New England that this type of surfacing cannot be overlooked.

We must recognize that with good materials and fulfillment of specifications that bituminous macadam has and is still giving excellent service.

Its cost is sometimes higher in parts of New England than bituminous concrete, due to the fact that only the best trap rock is accepted. Results, however, seem to justify this, as we find many miles of bituminous macadam carrying heavy traffic with no more than a normal amount of maintenance cost.

The investigation as conducted so far makes evident the possibilities of classifying between limits the many types, by cost, traffic capacities, soil and climatic conditions, as well as drawing other useful conclusions which will assist the engineer, the producer of materials and equipment, and the contractor in selecting, building, and maintaining low-cost improved roads.

HIGHWAY BEAUTIFICATION ESSENTIAL ELEMENT IN FUTURE CONSTRUCTION

By Col. C. O. Sherrill, City Manager, Cincinnati, Ohio.

(From "Highway Topics" for July, 1927)

The day is past when we can allow ourselves to be satisfied simply with a smooth, hard pavement eighteen to twenty-four feet wide, without giving thought to a number of collateral matters essential for a complete highway system, whether in city or in rural districts. A few years ago, and a very few at that, our highest ambition as road builders was to get a water-bound macadam road twelve to sixteen feet wide. In fact, I can remember distinctly my first road-building experience in the Philippine Islands as a young Lieutenant of Engineers was in trying to keep a mud road 75 miles long in northern Luzon passable for the army trains during the rainy season of 1901. We thought we were lucky if the escort wagons could get through without going down to the hubs.

In that year there were 14,800 motor cars in the whole United States. In 1926 there were 22,201,393. This stupendous growth is a fair measure of the increased importance to the people of the country of the motor car in the everyday life of the average person. Today the motorist kicks like a steer if he finds the smallest rough spot in the road, whereas a few years ago he was delighted to get on one where he was reasonably free from mud and dust. The motor car has advanced from the luxury class until today it is rated as an absolute necessity to every family.

Along with this development the demand for more and better pavements has become so insistent that all other city, county, and state needs take a back seat in favor of highways. These highways must now be made wide enough for several, at least, four, lanes of traffic; curves must be perfectly banked to give safety at high speeds; grades eased off to make their climbing easy, the roadbed must be substantial enough to carry the heaviest loads of interurban buses with forty or fifty passengers, and trucks carrying 20,000 to 30,000 lbs. They must have all the traffic aids necessary under the modern conditions of dense traffic movement, such as lines to mark the lanes, beacons and traffic lights to automatically control and direct traffic, complete systems of route markers to guide infallibly the motorist on the best route across states, and even across the continent. Heretofore our efforts have been directed to barest utilities, now the time has come when motorists will no longer be satisfied with the useful alone—they are beginning to demand the beautiful as well. The pleasure of driving can be immeasurably increased by having the

road-side free from ugly sign boards disfiguring the landscape.

The same demand for beauty is beginning to point the way to more attractive and artistic designs in utility buildings along the routes, such as gas filling stations. These are becoming so numerous that the slightest distinctive feature in any one of them will draw a great deal of business, whereas the ugly, greasy, filthy, ill-kept station will see a constant reduction in the number of their customers and the resulting profits from their business. Some stations now provide clean, sanitary, toilet facilities and rest rooms for men and women and attractive reading and lunch rooms are occasionally found. How often these features will determine at which one of a dozen stations you will stop to fill up with gas and oil, and perhaps stay over for lunch. I fully believe that a gas station designed and maintained with the utmost care for all conveniences and with beautiful buildings and surrounding grounds, and commodious and attractive entrance drives will get the business away from competitors who give no thought to these refinements.

Although it is unfortunate that our people cannot generally be counted on to go in for beautification for itself, alone, yet the financial returns are so great that even those whose only object is the making of money should, from this point of view alone, be induced to do their share in making our roadsides more attractive. There is no reason on earth why a gas station should not be a delightful stopping place so inviting that motorists can only pass it by with regret.

The disfigurement of our roadsides by billboards is another unpardonable evil, now beginning to be recognized as such by all those interested in good highways —an evil that should be blotted out, and in fact, is now being blotted out in some progressive states through regulations forbidding billboards within a considerable distance of the road, on the ground that they distract the motorists' attention or conceal the road ahead, thus being a menace to safety. They certainly destroy the restfulness and charm of the countryside, for which tourists pay thousands of dollars to enjoy the rural parts of England, France, and other European countries. I believe billboards should be absolutely forbidden on highways on the same basis as they are forbidden by the zoning regulations of progressive cities on principal boulevards and in residential districts.

Other disfiguring features often found along our road-sides are refuse dumps; unsightly, higgledy-piggledy rows of rural free-delivery mail boxes on poles of various shapes, heights, and kinds standing at various angles, giving a most ugly effect. Then we have the unkempt, disordered, littered barnyards and ramshackle outbuildings on farms. Fortunately, these are becoming less frequent as roads become better and traffic becomes heavier, for there is a distinct psychological effect of these improvements which forces people living along the way to spruce up, paint up, cut down weeds, repair fences, plant flowers, and care for lawns.

As a pure matter of business it behooves property owners along the roads to beautify their homes, as this induces travel, and travel means money spent along the way. The tourists each year to France from America spend enough money to balance her budget, and if she were so inclined, allow her, in addition, to pay the interest on her war debts to America. Our people, unfortunately, do not yet fully appreciate the immense sum spent along the road by tourists.

In addition to this financial value, the joy of living and traveling in beautiful surroundings is more than enough compensation for all the cost and trouble involved in making our road-sides clean, orderly, free from litter, and hence, beautiful.

Let us start a movement for beautification along every road in Ohio, and take the lead in this, as in other features of highway development.

HIGHWAY MAINTENANCE IN OHIO

By George E. Carr, Chief Engineer, Bureau of Maintenance, Ohio Division of Highways, Columbus, Ohio.

(From "Highway Topics" for April, 1927.)

Highway maintenance is rapidly becoming the biggest problem confronting the highway engineer in Ohio. We are thinking of the State Highway System as being almost completed by some type of construction which renders it serviceable throughout the year, and such thought carries with it the idea of maintenance to insure this serviceability. Even the remaining small mileage of earth roads on the state system is de-

serving of maintenance which will increase the efficiency of these roads, at, least, one hundred per cent.

Within the last four years some three thousand miles of state highway have been constructed of the "traffic bound" type. This work has been carried on, very largely, on a co-operative basis, with the various counties. It is true that a part of this mileage was on less heavily traveled routes but all of these improvements have been of very great local importance, and a number of these routes have developed an unexpected heavy traffic. Traffic bound roads have been brought to a condition through county co-operation where they are serving all local requirements and there is a feeling that the counties should be relieved of any further burden arising from the maintenance of these roads. It is also felt that if certain users of these roads demand a higher type of construction, that they should finance this higher type. It, therefero, seems necessary for the State to assume the burden of the maintenance of the "traffic bound" roads.

About eight hundred miles of earth road remain on the State System in an undeveloped condition which it is hoped can be improved by "traffic bound" methods in the next two years. This mileage is made up of a number of short sections which, in many instances, is preventing traffic on routes already seventy per cent. completed between county seats. The completion of these sections will bring the "traffic bound" maintenance to about 4,000 miles.

It is planned to pave some 600 miles with more permanent types of pavement. This is mileage on which the traffic is and will be heavy, and on which "traffic bound" types will not be economical or practical.

There are at present about 6,400 miles of hard surface pavement on the State System, including 350 miles of county built improvements, that are being maintained entirely at State expense. It seems imperative that this part of our system be maintained, if in so doing, it is necessary to curtail construction and "traffic bound" maintenance. A tremendous investment is involved in hard surface pavements and this investment must be preserved if we are to receive value received from it. It is believed that sufficient finances will be provided always to take care of this feature of our work, although it is doubtful if they will provide for carrying on the other work as extensively as the public will demand.

The subject of maintenance covers so many activitiest that it will not be possible to go into any great detail, but it is felt that in touching on some of the more important features that our problems may be better understood.

Roadbed Maintenance

Roadbed maintenance, since it involves drainage, is a feature of primary importance. If the sub-grade can be kept properly drained it is certain that the life of the pavement will be greatly increased. This problem differs greatly in different sections of the State, as the climatic, topographic and soil conditions change. In the extremely level sections of the State it is necessary to depend entirely on artificial drainage. It is difficult to keep the water level a sufficient distance below the road metal to insure a stable foundation. In these sections these ditches generally lead to an artificial county ditch, and the gradient is so slight that many weeks are involved in freeing the roadsides from water. Tile farm drains empty into the roadside ditches and this prolongs the saturation period.

It is necessary to keep the ditches free from trash since this often clogs culverts and farm drains and stops the free flow of water. In the more rugged sections on steep grades heavy rains cause the ditches to wash much deeper than desired, and many times the shoulders are washed away. It is often necessary to pave the ditches or build stone breakers to prevent the wash. Seeding of shoulders has been found advisable to stop wash.

There is no better time to study drainage conditions than during the wet season, and superintendents are required to carefuly inspect their roads at this time. Ditches should be opened every spring with grader or by hand and the material removed if not needed on the shoulders. The destruction of a pavement is often prevented by constructing "French" drains from the edge of the road metal through the shoulder to the ditch. This is particularly true where the roadbed consists of dense clay which is almost impervious to water.

Shoulder Maintenance

Shoulder maintenance on pavements sixteen feet or less in width is becoming a serious problem on the heavily traveled routes. With the present day bus and truck traffic it is certain that a high

percentage of the vehicles will leave the pavement in passing. This has required the application of stone, gravel, slag and other materials to the shoulder along the edge of the pavement to insure safe travel. When earth comes in contact with the edge of the pavement a bad rut forms which is extremely dangerous to the motorist and is detrimental to the road surface since it holds the water and softens the roadbed under the edge of the pavement. This condition is worse on steep grades since all horse drawn vehicles follow the shoulders and form ruts along the edge of the pavement which invariably start bad washes. After the stone, gravel or slag is applied to the shoulder it requires constant maintenance. It is necessary to drag the shoulders several times each week to keep the material in proper position.

A very marked reduction in the maintenance of this nature is noticed on pavements over sixteen feet in width.

Nothing improves the appearance of our highways more than to keep the shoulders properly mowed and cleaned. The grass and weeds are mowed twice each year. This is done with machinery to a considerable extent, but much hand work is required in the ditches and along the fences. It is always desirable to burn this trash as soon as dry to prevent it getting into the ditches and stopping the proper drainage.

Slips (Removal and Prevention)

A great amount of money is spent each year in the removal and prevention of slips. There are two kinds of slips —those which come in from about the road filling the upper ditch and blocking the roadway, and those which slide out from beneath the roadbed generally carrying the road metal with it.

The slip which comes down from above is much less troublesome and easier to conquer than the second class. The principal solution for the first class is to remove the material basck as nearly as possible to the original slope. These slips are hard to handle since they are composed of clay, rock, trash, etc. This is very expensive hand work, but small gas shovels and truck cranes have proven very economical units. The material can generally be wasted at narrow fills thus serving the purpose of widening the roadbed. Occasionally piling can be driven above the ditch line if the overburden is not too great. This is more or less temporary since when the piling rots off the same slip will develop again.

The second class slip is one for which no fixed solution will apply. Each individual slip is a problem in itself and has its own solution. It is necessary to make an investigation and study the cause. It is advisable to make borings to determine what and where the slipping plane is. If it is clay or other material into which piling can be driven, this will be the solution. Piling can be driven as closely outside the shoulder as possible and the backfill made with cinders, slag or other materials with as little weight as possible. If the slipping plane is shale or rock into which piling can not be driven the problem is serious. Permanent results have many times been obtained by drilling and shooting this rock, thus breaking up the slipping plane. There are times when this is not possible or practical. In this event it seems advisable to go to considerable expense to relocate the road farther back on the rock shelf and keep away from the slip. The only other relief can be a concrete wall or concrete piling either of which are very expensive. A great number of slips develop along the larger streams during floods. When the waters recede slips several hundred feet in length develop where the roads are near the river bank.

Surface Maintenance

Each type of pavement has its own peculiar method of maintenance. Since about all types of pavement exist on our highway system, it is evident that our surface maintenance problem is very complicated. Finances not permitting the replacement of many worn out pavements, our operations are not always economical, but must be carried on until replacement is possible.

The maintenance of traffic bound surfaces is largely a matter of dragging. To carry on this work properly it is always necessary to have the necessary amount of loose material on the surface to fill all depressions in the road and carry a mulch of ½ to ¾ inch on the surface. The material is added in the spring of the year and carried in winrows on the shoulders so that a small amount may be dragged in as it is taken up due to the action of the vehicles. Heavy drags are necessary to keep the chatter bumps out of the surface and after this has been accomplished the motor patrol grader seems to be the most satisfactory for keeping the material properly placed on the surface.

Macadam surface maintenance consists of patching and surface treating. Hand mixed and ready mixed bitumin-

ous tar and asphalt materials are used successfully on this work and applied as early in the season as weather conditions permit. However, these operations must be carried out to some extent through the entire year and as rapidly as pot holes form in the surface they should be repaired. On roads where heavy truck traffic exists quite often a depression will form eighteen inches in from the edge of the pavement which has a tendency to hold the water on the surface and soon destroys the edges of the pavement. These depressions should be patched from time to time and the true cross section of the pavement maintained. Many of the old macadam pavements were built with an excessive crown and it has been found practical to work this crown out of the pavement by building up the edges with two or three inches of cut back material running it out to a feather edge toward the center of the pavement.

To properly maintain macadam pavements it is necessary that the surface be kept as nearly as possible impervious to water. To accomplish this it is necessary to surface treat with tar asphalt every two or three years. It is very desirable that these treatments be carried forward as early as possible in the season in order that they may have time to be properly ironed out and sealed before cold weather. Where light tars are used only a light application of covering material is applied but when hot tar or heavy asphalt is used a heavy covering of stone chips is used and best results are obtained by thoroughly rolling this covering material so that none of the stone may be wasted. On many macadam sections which have been built for light traffic it is possible to build up a mat which will be of considerable service and will add very greatly to the life of the road.

Many types of brick pavements have been constructed in different sections of the state. Quite often advantage has been taken in the use of local materials. Miles of brick pavements have been constructed on sandstone base with sand or granulated slag cushion. These pavements generally become rough under heavy traffic. About the only solution in the maintenance of this type of pavement is to relay the brick on a new slag cushion. It has been found that the maintenance cost increases very greatly where the proper curb has not been used in the original construction. It is many times necessary to relay a strip there feet wide along each side of the pavement where truck traffic has caused a depression which holds the water. Brick pavements that have been built on rolled slag foundations are requiring less maintenance than those on sandstone foundations but even then a considerable amount of brick patching is required. On some of the very heavy traveled roads we have brick on concrete foundation. A failure on this type necessitates the replacement of the base with new concrete and is found very expensive.

Maintenance of concrete pavements differ from the other types in that but very little material is used. Early in the season the cracks and joints are cleaned and filled with tar and this application generally lasts for a year although it is always advisable to go over the road late in the fall and see that all cracks and joints are properly waterproofed before winter. If there is a complete failure in the surface it is necessary to take out the broken pavement and replace with new concrete patches.

Winter Maintenance

A few years ago very little, if any, maintenance was carried on during the winter months. Traffic has come to demand that the roads be kept open during the entire year and snow removal has developed into an operation of considerable importance. Great effort has been made to keep the main traveled roads open to traffic at all times and considerable snow removal equipment has been necessary. Of course, this work applies to only certain sections of the state, particularly the northeastern part. It is believed that aside from the standpoint of the traffic this work is also justified on account of the protection it will be to the road. If the snow is permitted to remain on the pavement ice ruts will form and in some cases the surface has been almost destroyed in the wheel tracks. Snow fences for the prevention of drifts are placed in the late fall and removed in the early spring.

The winter season is the proper time for repairing all equipment and painting it for the next season's work. Garages have been established in each division which provide for this work. Each garage ois supplied with machine shop equipment and a considerable stock of parts is carried to take care of these repairs. It is intended that when this equipment leaves these garages in the spring it is in the very best of condition and should be good for the season's work.

Quite a number of men are occupied on this work during the winter and these are quite often the same men who operated the equipment out in the field during the summer. In this way our forces are kept employed a greater part of the time and it is thus possible to retain good men on the work.

W idening and Resurfacing

The problem of widening and resurfacing is probably the most expensive and far-reaching of any with which the department is confronted at this time. On the state system there are many miles of narrow pavements which were built years ago before traffic demanded a wider pavement. Just how to widen these pavements and get the full salvage value out of what already exists is a serious question. It would not be such a problem if only one type of pavement existed on our system, but since there are so many different types it is necessary to provide a number of solutions to take care of the whole situation. Each particular section furnishes its own problem. On many jobs widening and resurfacing go together. To properly widen a section it is also necessary to resurface. Many macadam sections can be widened and resurfaced by placing a three foot concrete edging and a new macadam top course. Old narrow concrete sections can be widened with a concrete edging and a new brick or other type wearing surface. There are very few cases where it is possible to widen the present pavement without at the same time doing some work on the existing pavement. Funds have not permitted carrying on this work as rapidly as it should be done. Resurfacing will probably cost on an average of $25,000 per mile and widening will possibly average $10,000 per mile. Knowing that a considerable part of our mileage is too narrow and many years old, it is safe to say that we should be resurfacing and widening three or four hundred miles per year, whereas, we are probably not accomplishing half that much. If this part of our work falls behind, the regular surface maintenance cost will of necessity be much higher than it should be.

Bridge Maintenance

The matter of bridge maintenance is an activity which has been given but little thought until within the last two years. The rapid development of traffic bound roads has seen the bridge program fall far behind. This means that particular attention must be paid to the maintenance of those old structures which are known to be too narrow and of weak design. Inasmuch as it will not be possible to replace these bridges as rapidly as they should be replaced more money must be spent on maintenance. Many old steel structures have not been painted for twenty years and a consistent effort has been made to get these structures painted, the bridge floors replaced and everything possible done to place them in satisfactory condition to carry the traffic for the next few years.

Signs and Markers

The matter of erecting signs and markers has been carried on very extensively for the past few years to the end that the state of Ohio stands second to none in this respect. This is a work which requires persistent attention since the public has come to depend more and more on this feature of our work. Signs are continually becoming destroyed and must be replaced and repainted and to serve the purpose for which they are intended must be up-to-date at all times. This is a maintenance charge and a charge which it is felt has the full approval of the motorist.

State Highway Garage and Paint Shop

The central state highway garage and paint shop 80 ft. by 200 ft. has recently been erected and is located on the state fair grounds in Columbus. The lower floor of this shop is used for central garage purposes and the top floor is used as a sign and paint shop. Signs are manufactured, painted and cured by the most up-to-date methods. Considerable experimenting has been done with various kinds of paint and it is hoped that in the near future that certain kinds of paint which it is not now possible to purchase with any degree of certainty from commercial concerns will be manufactured by us. The central garage is used for storage of certain state equipment, for the repair of all department cars and for certain other specialized repair and machine work which may be shipped in from the various divisions. Also serves as a storage depot from which various material are shipped out to the divisions.

It is hoped that the above remarks will lead to a better understanding of the problems with which the maintenance bureau is confronted, and that our operations may meet the full approval of the motoring public.

RECENT PROGRESS IN SEWAGE DISPOSAL AND STREAM POLLUTION PROBLEMS

By Isador W. Mendelsohn, Associate Sanitary Engineer, U. S. Public Health Service, Chicago, Ill.

(Paper read at 1926 conference on Sewage Treatment at Ames, Iowa.)

Stream Pollution, including sewage disposal, is an important problem throughout the United States at present. In its widest aspect, it includes the discharge of sewage, trade wastes (from beet sugar plants, canneries, chemical, coal tar, gas, corn metal, and milk products plants, mining operations, oil and refining, packing, the rendering plants, paper and pulp mills, tanneries, and textile industries), and other matter, whether from municipality, industrial establishment, institution, or dwelling, into bodies of water used for any or all of the following purposes: (1) human consumption as for drinking water; (2) production of food as for watering stock, irrigation, and propagation of fish; (3) disposal of wastes such as industrial wastes and domestic and municipal sewage; (4) production of power; (5) transportation; (6) recreation, including fishing and bathing. The relative importance of this problem is well brought out in the statement of Dr. Monger, Director, Ohio Department of Health, that "at no distant date, water protection will probably be the 'livest' question confronting the sanitarian."

Much has been, and is being, done towards solving stream pollution problems in various states, particularly in the last five years. Among the noteworthy developments in this period are the following: (1) cooperation between governmental agencies and private industry; (2) recognition of the joint need of sewage treatment and water purification on certain bodies of water; (3) improvement in the status of sewage plant operators; and (4) the importance of pure research in stream pollution.

Cooperation Between Governmental Agencies and Private Industries.

It is recognized by all that disposal of municipal and industrial wastes has burdened, water purification plants, caused water borne disease outbreaks, and produced foul and unsightly conditions making bodies of water unfit for fishing, bathing, and other recreational purposes. Accordingly, in the interests of an awakening public demand, municipalities and industries contributing wastes are more and more willing to alleviate the conditions. Government officials have sensed this feeling, with the result that they are investigating stream pollution matters in a manner such that all interests will be wisely served in the order of their value to the public, at minimum expenditure of public and private funds. The order of precedent of use of water resources, as stated in a progress report of the Committee on Sanitary Conservation of Streams of the Conference of State Sanitary Engineers in June, 1926, is: (1) source of public water supplies; (2) conveyance of sewage and industrial wastes after suitable treatment when and where needed; and, thereafter, as determined by local circumstances, for manufacturing, industry, power, irrigation, agriculture, fishing, recreation, or navigation.

With the realization of common interest in stream pollution has come cooperation of effort in solving the problems. This cooperation has developed among health officials themselves, between state departments of health and other state departments and between state departments and private industry. All gain through such cooperative effort, the strong as well as the weak. Examples of such cooperation and the results achieved are as follows:

1. Agreement in 1921 between Sanitary District of Chicago and U. S. Public Health Service for the survey of pollution of the Illinois River and its effect upon cities located on the river. This survey was carried out in 1921 and 1922.

2. Agreement between New Jersey and Pennsylvania State Departments of Health in 1922 regarding disposal of sewage into the Delaware River.

3. Agreement between State Departments of Health of Pennsylvania, Ohio and West Virginia in November, 1924, for the purpose of establishing uniform policies and the exchange of information on the prevention of pollution of the Ohio River drainage area. This agreement was extended in 1926 to include the health departments of Kentucky, New York and Maryland. The health departments of Indiana, Illinois, and Tennessee have recently applied for admission to this agreement. One noteworthy result of this agreement has been the elimination of most of the phenol wastes from by-product coke plants from the

Ohio River, with resultant decrease in the occurrence of bad taste in water supplies of cities located on the river.

4. The Delaware River Compact in 1925 between Commissioners of New Jersey, New York, and Pennsylvania, with definite requirements for treatment of sewage before its discharge to the Delaware River, and commensurate requirements concerning industrial wastes, and provisions concerning the degree of cleanliness of tributary streams at their confluence with the Delaware River.

5. Agreement between State Departments of Health of New York and Pennsylvania in 1925 regarding the pollution of boundary streams.

6. Agreement in 1925 between City of Chicago, Sanitary District of Chicago, State Departments of health of Illinois and Indiana, and the U. S. Public Health Service for the survey of the pollution of the lower end of Lake Michigan as affecting the water supplies of cities in Indiana and Illinois. This survey has been completed and a report prepared in June, 1926.

7. Agreement between State Departments of Health of Michigan and Ohio in 1926 in regard to uniform policies in the control of industrial wastes in general, including wastes from beet sugar, paper, milk, and canning industries.

8. Agreement between State Departments of Health of Minnesota and Wisconsin and the U. S. Public Health Service in 1926 for the investigation of the pollution of the Upper Mississippi River.

9. The National Committee on Stream Pollution for the Pulp and Paper Industry was created about April 1, 1926, with two representatives of the industry from mills each in Michigan, Wisconsin, Ohio and Pennsylvania, one in Massachusets, one in Maine, the Secretaries of the Technical Association of the Pulp and Paper Industry and of the American Paper and Pulp Association, and the Chief Engineers of the State Departments of Health of Wisconsin, Ohio, Maryland, and Pennsylvania. This committee will obtain information concerning the unsolved problems relating to the disposal of pulp and paper mill wastes through studies and investigations being conducted by their own consulting engineer. The Association has assessed its members $15,000 per year for three years for this work.

10. In 1923 the Cleveland water supply was seriously damaged by phenol wastes. Conferences of the City and State Health Departments with the local industries brought a voluntary agreement by the steel plants to stop this pollution. Within a year the three plants had completed installation of a treatment process at a cost of several hundred thousand dollars which has practically eliminated the nuisance.

11. In Wisconsin the Pea Packers' Association, at the request of the State Board of Health, assessed their members $500, to assist in certain research regarding the disposal of their wastes during 1926.

12. Although tannery wastes are specifically exempted from the provisions of the Purity of Waters Act, the companies operating leather tanneries located on Pennsylvania streams have executed an agreement with the Pennsylvania Sanitary Water Board under which they are providing $35,000 to study tannery waste disposal including construction and operation of a full-scale treatment works at Instanter, Pennsylvania.

13. In Michigan the canneries have assessed themselves $0.002 per case based on the 1925 pack, to make an investigation of treatment of their wastes at an experimental station at Kent.

14. In Ohio the Canners' Association provided funds in 1925 and established a testing station at Canal Winchester with a consulting engineer in charge.

15. The addition of industrial wastes to municipal sewage results in added public expenditure in the building of a sewage treatment plan. At Dayton, Ohio, where a complete sewerage system and treatment works is planned, studies made by the city relative to receiving into the city sewers the untreated liquid wastes from certain paper companies showed that this would increase the cost of the total plant by about 80 per cent, or over $700,000. Action taken by the State Department of Health resulted in the installation of treatment methods at one of the paper plants that have produced a saving of 120 per cent annually on the entire cost of the installation.

16. In 1924, a meeting took place of representatives of the League of Ohio Sportsmen, Izaak Walton League, Ohio State Grange, Farm Bureau Federation, Ohio Manufacturers' Association, and state agencies to stop stream pollution. Through the work of this meeting a bill was prepared and became a state law on March 19, 1925. This act provides that the State Department of Health shall (1) approve of any new or increased dis-

charge of industrial wastes; (2) supervise the operation and maintenance of industrial wastes treatment plants; and (3) adopt regulations necessary to prevent undue pollution of streams and to protect the public health. The plan of enforcement provides for the issuance of official orders by the State Department of Health, with the advice of an advisory council representing the manufacturing industries, sportsmen, agricultural interests, municipal officials, and others.

After passage of the bill, the coke, paper, beet sugar, steel, milk, and canning industries were separately invited to conferences. Organizations of the industries for the sole purpose of collectively attacking their problems were perfected, and ways of financing them properly were devised. Executive committees empowered by each industry to conduct necessary experimentation and research were authorized. According to Mr. Waring, Chief Engineer, the State Department of Health is cooperating with the group organizations by furnishing each with a detailed list of companies and circumstances where the wastes disposal problem is causing complaint and needs attention. Agreement is reached with the committee and the particular company on the one hand and the State Health Department on the other; and the devices are installed.

The same legislature passed a sewer rental law permitting municipalities to assess property owners for sewerage service, and thereby provide for proper maintenance and operation of sewerage systems.

17. The "Administrative Code" of Pennsylvania (approved June 7, 1923) created in the Department of Health the Sanitary Water Board, consisting of the Secretary of Health as Chairman, the Secretary of Forests and Waters, the Attorney General, the Commissioner of Fisheries and the Chairman of the Public Service Commission. This Board executes the statute formerly administered by the Health and Fisheries Departments, and it is also clothed with investigatory powers. Since June 1, 1925, the Board has been provided with separate funds for its work.

This board through the issuance of permits: (1) stipulates the conditions under which municipalities may lawfully discharge sewage into state waters; and (2) approves plans of sewers and sewage treatment works and supervises their operation. Although the Board lacks these powers in regard to industrial wastes, the statutes referring inferentially to industrial wastes are prohitive in character and provide for penalties.

The Sanitary Water Board is (1) making surveys for the classification of streams; (2) furthering proper municipal sewerage and sewage disposal projects; (3) cooperating with industry to find reasonable and practicable means for disposal of industrial wastes and where possible, recovery of by-products.

18. In Michigan the 1925 state legislature amended the empowering act of the Conservation Department, greatly strengthening the law regarding offenders. At the same time an act was passed permitting municipal authorities to issue bonds for sewage disposal plants without a vote of the people when such municipality is ordered by this Department or the court to build a disposal plant. The State Departments of Health and Conservation together started a campaign toward improving stream pollution conditions. Conferences were held with groups of municipalities on various river basins. At the end of each conference, orders were given each municipality requiring preparation of plans for sewage disposal plants and removal of raw sewage from the streams. After these conferences, the various industries were called in groups. Each group was required to formulate plans for the removal of their wastes from lakes and streams.

19. At the meeting of the Lake Michigan Sanitation Congress on Sept. 25, 1926, President Folds of the Izaak Walton League stated that the present aim of the League is to "clean up water supplies." The cooperation of various agencies will be enlisted by the 2700 chapters of this League in studying and surveying stream conditions throughout the United States.

With such excellent results as illustrated in the foregoing examples already obtained through cooperative efforts of all parties concerned, it is believed that this method of procedure will be adopted widely and will be productive of many other and more notable achievements in stream pollution prevention in the future.

Recognition of the Joint Need of Sewage Treatment and Water Purification on Certain Bodies of Water

For some time past sanitarians and water and sewerage works officials have been discussing the relative importance

of sewage tretament and water purification as to how far each should be resorted to in providing a safe public water supply from a polluted surface stream. Fortunately, data regarding sanitary surveys of pollution and natural purification of streams published in the past few years has shed light on this discussion.

Since 1910 the U. S. Public Health Service has been making studies at Cincinnati and elsewhere of various phenomena concerned with the pollution and natural purification of streams. From the data collected, methods have been derived whereby it is possible under certain known conditions to determine the extent of pollution in a stream at various points due to a source of pollution, and to estimate the pollution load at present or in the future upon a water purification plant whose source is a polluted watercourse. In applying this information to the study of water filtration plants along the Ohio River, Sanitary Engineer Streeter found that only by effective use of constant chlorination were the plants able to deliver the water of such bacteriological quality as is generally considered safe for a very large proportion of the time; and that "the problem of meeting further encroachments of pollution in the Ohio River has definitely entered the phase when serious attention must be given to some plan for restricting further increase in the sewage pollution of the river."

In a very thorough and comprehensive report of the investigation of the pollution of the lower end of Lake Michigan in the Calumet region in June, 1925, by Sanitary Engineer Crohurst and Past Assistant Surgeon Veldee, information is presented showing that, as a result of the large amount of municipal sewage and industrial wastes being emptied into the lake, the rapid sand filter plants of East Chicago and Whiting, Indiana, are handling loads far in excess of those ordinarily considered safe for water filter plants, and that the effluents from these plants and also from the chlorination plants at Hammond and Gary, Indiana, do not always meet the U. S. Treasury Department Standard. Speaking of the findings of this survey at the Lake Michigan Sanitation Congress on September 25, 1926, Sanitary Engineer Crohurst said that it is necessary to prevent city sewage and industrial wastes from entering the lake or else treat them before discharge in order that water purification plants may deliver safe water.

State Sanitary Engineer Finch, in speaking of the recent order of the Indiana Board of Health prohibiting discharge of raw or inadequately treated sewage into states lake including Lake Michigan, stated that Hammond, East Chicago, and Whiting have retained engineers to plan for the proper disposal of their sewage. Cities in Michigan located on the southern end of Lake Michigan are also being required by the Michigan Department of Health to install sewage treatment works.

At the same meeting State Engineer Baker of the Wisconsin Board of Health stated that from available analyses of lake water entering the Milwaukee waterworks intakes, the B. coli index indicates the water to be polluted to a greater extent than is found desirable for treatment by a water purification plant using chlorine alone in order to insure delivery of a bacteriologically pure water. Referring to the sewage treatment plant at Milwaukee which has been claimed by a certain part of the public to be more desirable in providing a safe water than a water filtration plant, Baker said no practical methods of sewage treatment alone can be depended upon to make Lake Michigan water safe for domestic consumption; instead, there must be in addition, water filtration and chlorination plants.

Speaking on the subject of "Filtration of Lake Michigan Water" at the same meetin, Consulting Engineer Paul Hansen of Chicago said (1) it is impracticable to obtain pure water from Lake Michigan without filtration; (2) chlorination alone must be considered an emergency treatment; (3) filtration and chlorination can not be depended upon to supply a pure water from Lake Michigan at certain places all the time.

In this connection it is interesting to note that at the present time an experimental station is being started by the Department of Public Works of Chicago to investigate the treatment including filtration of the lake water. It has been found that the water in the vicinity of the southern intakes is heavily polluted at times due to storms, heavy winds, etc., so that heavy chlorine dosage is necessary with resultant public complaint of chlorine tastes in the water.

With regard to the increase in sewage pollution of streams, Surgeon Frost of the U. S. Public Health Service, has

stated, "With the growth of urban population, which still continues at a rapid rate, the sewage pollution of streams and coastal waterways must increase, and sooner or later, in the absence of anticipatory control, it seems inevitable that eventually the pollution will become such that water purification plants of the highest efficiency will not be able to deliver consistently safe effluents. To guard against this condition it will be necessary, perhaps in the near future, to limit the pollution of such inland streams as are necessary sources of water supply by such measures of sewage treatment as will suffice to keep the pollution at waterworks intakes within definite bounds."

From the foregoing it will be seen that the time has arrived where conditions on certain streams make necessary both water purification and sewage treatment plants of such completeness and efficiency as will insure the delivery of a bacteriologically safe water to the public.

Improved Status of Sewage Plant Operators

The third noteworthy development in the field of sewage disposal and stream pollution recently is the increasing improvement in the status of the sewage plant operators. The installation of sewage treatment works at Chicago, Milwaukee, Cleveland and other Ohio cities, Pasadena and other California cities, and many others has resulted in the employment of a goodly number of experienced plant operators. The number will be increased rapidly as other works now in construction are completed, and still others to be planned are placed in operation. Naturally, with increased demand and larger plants requiring more experienced and capable sewage plant operators, the renumeration will be greater.

Only one state, New Jersey, requires that sewage plant operators must be licensed. In 1918 an act of the New Jersey legislature provided for the examination and licensing of superintendents and operators in charge of water and sewage plants. The intent of this act was to insure plant officials and provide for more permanent tenure in office of efficient men. The rules and regulations of the New Jersey Health Department provide for four classes of licensees: (1) first class or superintendents; (2) second class operator; (3) third class operator; and (4) fourth class operator. The requirements differ progressively from the latter class which call for qualifications and knowledge necessary to operate or control a settling or sedimentation tank of one or two story construction to that of the first class calling for qualifications and knowledge for satisfactory supervision of a sewage treatment works including screening, sedimentation, filtration, and disinfection and for making the standard tests, both chemical and bacteriological, necessary for testing the various processes, and for knowledge of the mechanical devices used in sewage treatment works. In 1925, there were 27 candidates for sewage plant operators' licenses in New Jersey, of which 22 passed.

Unfortunately, there is no national association specifically for sewage plant operators where problems particularly affecting them can be discussed adequately and through which provision can be made for publishing regularly papers on sewage disposal. Instead there are certain state associations. The best known is the New Jersey Sewage Works Association which publishes its annual proceedings. There is also a Texas Sewage Plant Operators' Association which publishes its proceedings. In Illinois there is an Association of Sanitary Districts consisting of representatives from about nine such districts. This association is three years old. At the annual meeting sewage disposal problems are considered among other matters. Kansas has an association or conference of sewage plant operators. In Iowa there is a Conference on Sewage Treatment at which matters relating to sewage disposal and stream pollution are considered. The papers presented at this conference are published.

Plans are now being considered whereby a union of State associations with the New Jersey Sewage Works Association as the nucleus will be formed. This union is to publish an annual containing the proceedings of each state association.

There is no reason why in time the position of the sewage plant operator in the United States should not be similar to that of the operator in England, where, according to Consulting Engineer George W. Fuller of New York, the waterworks engineer and sewage plant operator are placed in responsible executive positions, taking up directly with the Committee of Finance of a town financial matters regarding the operation and improvement of their plants, and their positions are considered of importance in the life of the community.

Importance of Pure Research in Stream Pollution

In the development of sewage disposal and stream pollution much research work was done in solving the various problems. Most of this research work was of the kind known as applied in that known methods of treatment are used in studying a certain waste to determine the most satisfactory process, generally in a small experimental plant or laboratory. The other type of research work is the pure or fundamental in which studies are made to determine underlying principles, such as those taking place in the biological life of a stream in natural purification. For progress in stream pollution both types of research are necessary, but pure research is of far greater importance. In general much more is accomplished for the advancement of a science in ascertaining an underlying fundamental principle. Unfortunately, pure research work is more difficult and less likely to receive the attention of the public. In stream pollution it receives much less support and recognition from appropriation bodies than applied research.

There are indications, however, that recently more attention is being given to the study of fundamental principles in stream pollution. Some of the types of research work now going on in stream pollution are briefly as follows:

1. The Sewage Substation of the New Jersey Agricultural Experiment Stations was established in 1921 in co-operation with the State Department of Health. Beginning with the present year, the Experiment Station alone is continuing the studies. This station is investigating the biology and bio-chemistry of sewage disposal. The Chemical Foundation has endowed the substation with $1,000 per annum to study certain phenomena in tank behavior. The President of the Dorr Company has established a fellowship at Rutgers University with the intention of having studies made on sludge conditioning and on separate sludge digestion at the Sewage Substation.

2. The Illinois State Water Survey is studying rates of sewage filtration with various depths of trickling filters; methods of analysis; and colloiders.

3. The Sanitary District of Chicago studies include: digestion of activated sludge with Imhoff tank sludge; collection of gas from Imhoff tanks; sludge drying on glass-covered sludge beds; use of ferric chloride for coagulant with activated sludge, the chemical being obtained from chlorinated copperas and rates of oxygen absorption and re-aeration conditions in the Illinois River.

4. At Harvard University, studies are being made in sludge digestion according to temperature and acidity conditions.

5. At Milwaukee tests are being made on dewatering activated sludge.

6. At Schenectady, New York, studies are being made on chlorination of sewage.

7. At Iowa State College, Professor Levine is making studies of the biological treatment of creamery and beet sugar wastes, also the types of bacteria found and methods of analysis.

8. In Wisconsin experiments are being made on pea canning and pulp mill wastes. It is intended to make studies in 1927 on corn canning, creamery and other industrial wastes.

9. In Pennsylvania, treatment of tannery, phenol, mine, and other industrial wastes is being studied.

10. In Ohio disposal of creamery, canning, paper mill, phenol, acid iron and other wastes is under investigation at experimental plants.

11. In Michigan, canning, beet sugar and other industrial wastes are being treated in experimental plants.

12. The U. S. Public Health Service is making the following studies at Cincinnati and elsewhere: (1) phenomena of bacterial purification in natural streams, and the biology of plankton forms in relation to bacterial purification; (2) laws governing natural processes of oxidation in streams, and methods of making the determinations; (3) relation of pollution of raw water to quality of effluent from experimental rapid sand filtration and chlorination plant; (4) investigation of pollution of streams in various parts of the country.

13. According to a questionnaire sent to State Health Departments early in 1925, some research work regarding stream pollution was being carried on by seven departments.

From a review of the foregoing studies now going on, it will be noted that there are many different kinds of fundamental research problems to be solved. Another problem is the effect of mechanical devices upon sewage treatment.

These problems may be carried out in two ways, either through individual efforts of laboratories or scientific work-

ers, or co-operatively. In the first case studies are made in laboratories and the principles are then tested out in sewage disposal plants; in the second case, the work is conducted by research organizations working together or dividing the problem, each taking a certain part. In both methods, information is required as to what work has been done elsewhere, also moral support and funds.

At present, a great deal of the research in stream pollution is done by individuals. In the course of such work duplication is involved, time lost, and funds and facilities are not used to the best advantage. On the other hand, it is possible through co-operative efforts to accomplish a large amount of valuable research work without duplication, with greater ease, more quickly and with more facilities. In carrying out a piece of cooperative research work, the major problem requiring solution is presented, analyzed into specific parts and divided in a systematic manner, by mutual agreement, among individuals or laboratories, so that when the work of each is accomplished, the sum total of all the efforts will furnish a solution of the problem for the benefit of all.

Instances of such cooperative research work are at hand in the case of the Committee on Standard Methods of Water and Sewage Analysis of the American Waterworks Association and the American Public Health Association, and the Association of Agricultural Chemists. Another example of cooperative work is the Union of American Biological Societies consisting of a federation of some fifteen societies of zoology, physiology, ecology, botany, and so on. As a result of the endeavors of the union, strongly supported by the National Research Council, a subvention of $350,000 for a period of ten years, was obtained from the Rockefeller Foundation for the establishment and maintenance of a much-needed comprehensive journal of biological abstracts.

Herbert Hoover in a recent address before engineers in which he made a plea for the advancement of fundamental scientific research in this country said: "The time has gone by when we can depend very much upon consequential discovery or invention being made by the genius in the garret. A host of men, great equipment, long patient scientific experiment to build up the structure of knowledge, not stone by stone, but grain by grain, are today the fundamental source of invention and discovery." In this Mr. Hoover does not overlook the genius, and wishes to provide assistants, equipment, etc., for him; but his main plea is not to depend upon the genius alone.

As Dr. Vernon Kellogg of the National Research Council so aptly states, "great philanthropic foundations are inclined to count the need more than the amount of money involved. They are inclined to be generous to those who can show a real need, and especially are they well-organized groups of men ready to inclined to be generous to more or less attempt to achieve a common goal by united effort.

"The scientific body, to whose upbuilding I am at present giving all my attention and effort, wants to promote in every way possible to it the sound development and increase of scientific research in this country. It wants to avoid interfering in any way with what is already going forward in this direction; least of all things it wants to dictate to any scientific man or men the things he should do. There is fortunately no possibility of the National Research Council, or any other body, ever being able to dictate to scientific men; scientific men will suffer no dictation. But it wants to help, in making things easier for scientific workers from geniuses down; it wants to influence colleges and universities to recognize ever more clearly their research responsibilities; it wants to make clear to the great industries how inescapably their success depends on scientific advance and hence that they should in every way encourage such advance! it wants to bring the support of the great philanthropic foundations, with their large financial resources, to scientific men and undertakings. And it believes in cooperation and coordination of effort."

It would seem desirable for engineers, chemists, bacteriologists, and others interested in stream pollution to unite in some kind of organization for the advancement of knowledge of the various problems of stream pollution. Such an organization could consider the major problems in this field and by mutual agreement of various laboratories and workers, distribute the problems or parts of the problems to each for solution, and, when all units are completed, could disseminate the scientific data to all. Such an organization could seek for funds and assistance from the National Research Council, Engineering Foundation, and private industries and philanthro-

pists, to provide equipment and other assistance for individual laboratories and to establish a clearing house for information on all phases of stream pollution. Cooperation and coordination have proven invaluable in other walks of life in the United States; it is worth while trying them out in research studies in sewage disposal and stream pollution.

Summary

Among the recent developments in sewage disposal and stream pollution in the United States are: (1) cooperation between governmental bodies and private industry; (2) recognition of the joint need of sewage treatment and water purification in certain streams; (3) improved status of sewage plant operators, and importance of pure research in stream pollution. The desirability of cooperation among laboratories and other research workers in solving stream pollution problems is pointed out.

STONE BASIS FOR ROADS

By Rodman Wiley, Vice-President and Sales Manager, Kentucky Rock Asphalt Co., Louisville, Ky.

(Paper read before Louisiana Engineering Society, New Orleans, La., June 13, 1927.)

It is always a great pleasure to address an assembly of engineers. When we consider the influence of engineers as it affects men in every walk of life today, we realize more fully the importance of the two requisites—fairness and open-mindedness on their part. As a matter of fact, practically everything of use to man today, not made by Nature, is the work of an engineer—the railroads, water-works, highways, radio, telephone, telegraph, electric light—in fact, all useful things.

Very seldom is an investment of any large sum of money made without a favorable report from engineers of recognized ability. An engineer on all work is, in the final analysis, the sole arbiter in all matters pertaining to the work. He has more power than that delegated to any man or set of men elected to public office.

It is possible to have on the bench in a murder trial a judge who may be unfair to either side—prosecution or defense—but there are twelve jurors to hold him in check. There is also the right to appeal. It is possible to have on the bench of our highest courts men prejudiced on many subjects and against many things, but their associates have a voice in the decisions.

However, when it comes to construction work of any kind, specifications rarely admit of arbitration in case of differences. It is left to the opinion of the engineer as to what shall constitute good material, good workmanship, etc.

When you know and understand the power delegated to engineers, you appreciate the fact that the engineer, of all men in authority, must be broadminded, mentally honest and fair.

An engineer should be equipped with a good education, supplemented by years of experience. He should know every detail of the work he is supervising; otherwise someone will suffer—the contractor or the owner. It is just as unfair, just as dishonest for an engineer to fail to pay the contractor for work that he has done as it is for him to over-pay him. I cannot see any line of demarcation as regards honesty.

My remarks so far have been with the idea of impressing upon you the importance of approaching every question with an open mind.

Let us not get into the habit of arbitrarily condemning some type of work without making a thorough analysis of the proposition in question.

I hear stone bases for our highways generally condemned and, in my opinion, there is no reason for it.

Stone roads have, since the beginning of time, served for the convenience of man. The type has changed from time to time, also the details of construction, but in the end they were built of stone.

As you are aware, traffic conditions have changed greatly in the last few years, yet today we are building macadam roads and stone bases the same way they were built fifteen years ago. As a general proposition, the type does not prove satisfactory and, in my opinion, it is not the fault of the stone base, but the fault of the engineers designing and building it.

Recently, some real thought has been given to the design of broken stone bases. This, with particular reference to lateral displacement and subgrade conditions. It is my opinion that the principal failures of macadam and other types of stone bases are due to the fact that the voids have not been properly filled. This results in internal wear, causing an uneven surface.

In all the discussion that follows I am taking it for granted that drainage and unusual subgrade conditions will receive proper attention.

I suggest that a broken stone base be laid in thin courses so that the voids can be filled. The first course should be laid not over 4 in. loose, the stone shaped to the proper cross-section of the road and lightly rolled. I do not believe the roller should pass over it more than twice before screening (¾ in. to dust) are applied and broomed in. All visible voids should be filled, then rolled once or twice. Again apply screenings, broom and roll. Repeat this operation until the voids remain filled after thorough rolling. By lightly rolling and spreading the stone in such a thin layer the screenings, under the action of a roller, will shake down through the course of stone and thoroughly fill all voids; but if a thicker layer is spread, or if the stone is keyed too much before screenings are applied, the result will be that the course of stone is only checked for a depth of 1 or 2 in. below the surface, leaving the stone in the lower part of the course free to move.

This course should be lightly watered, but in no event with enough water to saturate the subgrade.

It is important that the stone and screenings be dry, otherwise it will be impossible for the screenings to sift down and fill the voids.

The second and third courses should be built as outlined for the first, except that the last course should be waterbound. The road should then be closed to traffic three or four days to allow it to dry. Excess screenings should be broomed off and the top laid.

It has been my experience that if the stone is spread in thin courses and care used in rolling, it is an easy matter to completely fill the voids and this will result in a rigid base, one that will remain smooth for all time.

This method of construction is no more expensive to the contractor than the method now used, except more screenings are required.

The average portable crusher will not, as a general proposition, make sufficient screenings, but this can be met by putting in a machine that will make screenings or else ship in desired quantity.

The thickness of such a base to carry modern day traffic must be left to the judgment of the experienced engineer.

A great many of us who have actually built roads in the capacity of contractors believe that greater stability is obtained when the first two courses are laid in one season and traffic allowed to pass over the base during the winter. The weak places that develop can be corrected in the Spring and the top course laid.

Modified Telford Base

The Modified Telford base came into some favor a few years ago. This was perhaps because of the wonderful service received from Telford bases built throughout the country, especially in Kentucky, between the years of 1810 and 1838. There are today in existence in Kentucky many sections of Telford base laid 80 to 100 years ago. Such sections have been unprotected by a proper wearing course of stone or by any waterproofing materials, yet they have withstood the action of traffic—have supported the loads. It is true, the work was done with a great deal of care and this was possible because of the cheapness of labor in those days. It does prove that design and details of construction really count—results in a worth while structure.

We know that some men will use the same amount of stone as that used by others under identical conditions, yet some roads are better than others. This shows the importance of details of construction.

There has been some dissatisfaction with the Modified Telford base in the last few years because of the fact that the surface would in a few years become uneven. Again I must say that I do not believe it is the fault of the type, but rather that it is due to faulty design and construction. The stone should, of course, be set shingle fashion, the idea being to break joint, the greatest dimension side of the stone set on the ground. The course should be about 8 in. in thickness and especial care should be taken to get the stone as near to ideal shape as possible. But the principal idea is to have each stone 8 in. in depth after knocking off the tops. Do not have some stone 8 in. deep—some 5 in., etc., and attempt to bring to proper thickness with spalls in an effort to use all stone shot down in the quarry. The fine pieces which are easily knocked off with a hammer will serve to chink and level up the course.

After knocking off the tops, the voids should be thoroughly filled with some very fine material. The idea in using a

fine material is to be certain it will sift through for the full depth of the course and completely fill the voids. It is best construction to do most of the void filling before very much rolling. In order to insure even compression some fine stone should then be spread on top of the Telford to properly even up the rough surface. Then roll until the course is well compacted. Apply more screenings, lightly water and roll.

Next apply a levelling course about 3 in. compacted. Fill the voids with screenings and water-bind. I think that if a base of this type is properly constructed it is one of the best types to build.

If greater depth is needed, add another course of stone and water-bind.

There are many sections of the country where sandstone and other soft stone can be found in abundance and I am sure that it can be used economically for a base under some kind of an asphalt top.

I have merely discussed the water-bound macadam and the modified Telford base. It is believed that these types cover the general field. All others will be modifications, made necessary to suit some local conditions. The main thing, regardless of type or size of the stone, is to fill all the voids.

We should study soil conditions and design each section of the road according to supporting power of the soil and loads that must be carried, just the same as we study these things when designing a bridge abutment or pier. It is rank foolishness to arbitrarily build the base the same thickness and type for the entire length of the road.

I am strongly of the opinion that good highway engineering should contemplate the use of local materials and I believe that if engineers will give more time and study to local conditions and local materials it will result in the saving of millions of dollars in the building of roads.

It may be found that the local materials do not meet standard specifications, but the base can be built thicker, or a new type designed, the idea being to use the local materials, if economical, to build a base that will support modern day traffic. It must be remembered that stone of an inferior grade can be used for a base whereas it would be totally unsuited if subjected directly to wear.

"Reconstruction"

There are now over our country a great many old roads surfaced with macadam and gravel where the alignment, drainage, etc., is good and about all that is needed is to strengthen the base and add a bituminous top.

I think the best construction is to dig a trench across the road the width of a shovel at many places and measure the depth of the present base. For the purpose of calculating the amount of new metal to use—consider the present base 50% of its real depth. In other words, if the base measures 6 in., value it at 3 in. The reason for this is the fact that the old metal is filled with dirt and other foreign materials and certainly should not be given a much greater value as compared to new stone and new gravel.

It has been my experience that the best way to proceed with such construction is to fill the holes, ruts, etc., in the present surface with stone or gravel—lightly scarify the surface and properly shape it with a grader.

There may be some question as to scarifying, but it is believed best to do this, especially if less than 4 in. compacted new material is to be added.

By filling the holes before scarifying, the weak places will be properly strengthened. If the holes are not filled before scarifying, it is my experience that the depressions will follow the base to the surface because very fine material will be dragged into the low places when the road is shaped with a grader and there is no stability to the fine material dragged into the holes.

After the surface is properly shaped, new material can be added for a sufficient depth to make a stable base.

Engineers are slow to adopt new suggestions, but it is my experience that they are the fastest class of professional men in the world to follow, when once something is started that has the stamp of approval of a few reputable engineers. In this process of following, specifications are copied, ideas are incorporated into the methods of construction and we do such things without proper thought. It is simply because it is successful in a wealthy state like Wisconsin, New York, etc., and we conclude that such states will not make many grave mistakes. This sort of engineering is most dangerous. It will in the end standardize types and methods of construction which perhaps are not economical, or are totally unsuited for the section of country in question.

We must stop copying and do some real studying. Analyze every proposition from an engineering standpoint.

Conditions vary greatly in our country and the real engineer is the one who digests every problem. He should not build anything without a good reason for doing it. He should make a complete report on every proposition and give engineering and business reasons for every important step.

The first cost of a road is, of course, most important, but of far greater moment is the cost over a period of years —maintenance.

The building of roads is here to stay. People are demanding more and better roads and they are providing the funds with which to build them. Highway engineering demands today the best brains in the land, because hundreds of millions of dollars are each year invested in roads. Is the money economically expended?

What will the future disclose as regards the billions now being invested in roads?

I think that the work of building roads will be a bigger one every year. As it stands today, and as it will always stand, no engineer should be so bold as to think he has solved the question as to the materials that should be used or types to build, because that varies according to available materials, soil conditions, traffic, funds, etc.

Let us as engineers, be as certain as possible, in the light of present day knowledge, that we are economically expending the road funds. This will require much investigation, but it will protect the engineering profession in the years to come. It will prevent any stigma being attached to our reputations, because of lack of study of each piece of work, because of mental dishonesty or because of moral weakness.

We must separate propaganda from facts. Millions of dollars are each year expended in advertising and in the publishing and dissemination of literature in an effort to influence the building of certain types of roads.

Technically trained, high salaried men are daily writing and lecturing in the interest of certain materials.

The principles of real engineering will separate the wheat from the chaff and we can thank our stars that against all of this we have as a balance-wheel the sane judgment of the real engineer.

CONSTRUCTION OF GRAVEL ROADS IN NEVADA

By Howard M. Loy, Assistant State Highway Engineer of Nevada, Carson City, Nevada.

(Paper read at 1926 Annual Convention of the Association of Western Highway Officials at San Francisco, Calif.)

From a standpoint of strict economics, the type of construction on any road should be governed by the traffic on the road or expected after improvement. In most cases, however, funds are limited, mileages are large and there is a demand for immediate improvement of existing conditions. This has lead to the construction of a large mileage of gravel or selected material surfaced highways.

Statistics of the Bureau of Public Roads show that on June 30, 1925, the Federal aid program consisted of 61,130 miles of highway, of which 27,560 miles, or 45 per cent., were surfaced with gravel or selected material. These statistics also show that in the eleven western States 62½ per cent of the program consisted of this type of construction. In Nevada 90 per cent of the construction is of this type.

Traffic conditions change rapidly, so that a gravel surface constructed today may, in a few years, be the base for a higher type of surface. Very often soil conditions in the roadbed necessitate a base course of this kind before a higher type of pavement can be successfully constructed. The gravel surface then serves the double purpose of an immediate wearing surface and later as a base for a more permanent surface. As the roadbed of any highway is more permanent than the surfacing or pavement, the alignment, grade and drainage structures should be planned and constructed so that only minor changes are required in case a higher type of surface is placed at a later date.

Usually gravel surfaces are constructed of local materials secured from deposits which have not been previously developed. A geological study of the country in the vicinity of the project will usually indicate locations where surfacing material may be found, even though the actual deposit does not appear on the surface. All deposits within a reasonable distance of the project should be investigated and the extent of the deposit, character of material and cost of handling determined. A selection can then be made of the deposits to be used on the project.

Surfacing material that gives the best

results is composed of angular particles and graded down from a maximum size of about 1 in. An excess of material between one-half and one-eighth in. in size is advantageous, but usually can not be obtained economically. The material passing the one-eighth in. screen should have distinct binding properties and should compose approximately one-third of the mass. The larger particles should be tough and durable to resist wear. Toughness is a better criterion for this material than hardness.

Seldom is a deposit found which consists of material meeting such a specification, and even by screening and crushing it is difficult to produce such a material from one deposit. The gravel may be round instead of angular. The grading may be far from uniform, and even by crushing and screening an exact uniform grading cannot be secured without elaborate screen installation and excessive waste of material handled. The fines may consist of sand with little binding property, or of dust with none of the small gravel and grit which is required in the mass for stability and makes an excellent top dressing.

If the deposit is deficient in binding material, it is often possible to develop a source for binder in the vicinity of the project and mix this with the gravel on the road without adding greatly to the cost of the project.

The difficulties of producing uniform materials have been largely overcome in Nevada by a specification which requires the crushing of all material in the deposit between 6 in. and ¾ in. in size as measured on circular openings. The crusher is set to produce a material of 1 in. maximum size. The product of the crusher, together with the material which passed the ¾-in. screen, is then run on a revolving or pitching screen with 1-in. square or 1¼-in. circular openings. Rejects from this screen are returned to the crusher or wasted. Passing all material over ¾-in. in size through the crusher produces a greater percentage of ½-in. to ⅛-in. material than would be produced by crushing only the material above 1-in. in size. The percentage of material under ⅛-in. in size, that is binder, is controlled by means of a ⅛-in. screen, the effective length of which can be regulated with adjustable plates. Excess fines are thus removed and wasted. The fine and coarse material is mixed and deposited in a bin, from which it is loaded into trucks. If the bins are filled from a belt or bucket conveyor it is usually necessary to install a baffle board on the bin to prevent the segregation of material.

Segregation of the material must also be prevented in loading the trucks. Loading from a side spout will cause the coarser material to carry over to the far side of the truck, so that when dumped on the road the material is still segregated. Trucks are best loaded from the bottom of the bin.

The thickness of gravel surface required varies for different climates and different soil conditions, but it is not usually feasible to place more than 6 to 8 in. of gravel on a project at one time. Best results have been obtained by constructing the surface in layers not exceeding 4 in. in thickness. In Nevada it is now the practice to require that the material be hauled over the first course but not over the top course. This hauling assists in the compaction of the material. All irregularities in the first course are removed and depressions filled with gravel before the second course is placed, and the surface is maintained as uniform and even as possible while hauling is in progress.

End dump trucks which, in the hands of an efficient driver, practically spread the gravel while dumping have given the best results. If the gravel is dumped in piles the entire mass must be moved in spreading, otherwise areas of unequal compaction occur and the result is a rough riding road.

For spreading the gravel and maintaining the surface during construction a road grader does only a part of the work required. A float or drag should be used to secure and maintain a true and even surface until the gravel is well compacted.

The percentage of fine material to be allowed will vary for different deposits and under varying conditions on the project. If the gravel is wet when hauled to the road, or watered immediately after dumping, the fines will hold up in the mass. If the gravel is dry the fines will often sift to the bottom, regardless of the percentage contained. If the subgrade material is fine soil some of this material will work into the gravel and appear as additional fines, but if the subgrade is hard there will be very little binder from this source. Also, the material placed near the deposit, which receives more hauling, requires less binder than the material placed further away.

It does not appear feasible under present methods to change the percentage of fines for each change in one of these variables. Practically the same results may be obtained by first determining the percentage required for average conditions and producing the material with this constant percentage and then, as the last step of the construction, adding additional binder to those sections of the road which appear deficient in this material.

Watering the subgrade just previous to placing the gravel assists materially in preventing the soil from coming up into the surface, and also helps to prevent the formation of chuck holes during construction. Compacting of the surface is also accelerated by the addition of water as the gravel is being spread and by frequently sprinkling the entire surface. In Nevada five gallons of water per square yard of subgrade is sufficient, and an average of fifty gallons per cubic yard of surfacing material is required to secure satisfactory results. At this rate ten to fifteen thousand gallons of water must be supplied and hauled to the road each day.

In many localities water is not available in such quantities, and the moisture necessary for thorough compaction must be supplied by rain or snow. In the more arid regions at least one winter season is necessary to compact the surface.

If the surface is kept smooth and in proper shape by dragging while compacting, an even smooth riding surface will result.

MOTIVE POWER OF INDUSTRY

By Dr. Henry Mace Payne, Consulting Engineer, American Mining Congress.

(Address delivered before the Fiftieth Convention of the National Electric Light Association, Atlantic City, N. J., June, 1927.)

When the chairman of your committee asked me to address you, he indicated a desire for me to amplify some thoughts which I expressed before the Southwestern Geographic Division of your Association at Galveston last year. I shall, therefore, direct your attention for a few moments to the achievements of industry in the United States, and discuss the problems of leadership upon which it is founded.

The quantity of manufactured goods now produced by the country is 163.4 per cent greater than in 1900. The number of wage earners employed was increased by 88.2 per cent while our productive mechanical horsepower increased 229.6 per cent.

Only two industries, liquor manufacture and shipbuilding, show a decrease. Automobile construction increased 4,800 per cent.

If we take only the past eleven years, we find that manufacturing has increased 65 per cent, or three and one-half times faster than the population increased, and that wages have increased at substantially the same rate.

This industrial world leadership is not the result of demagogic propaganda or secret alliances. America's prosperity is the fruit of intelligent power development, with skilled direction and mass production, paying the highest wages in the world, her workmen enjoying a higher standard of living than ever before.

Wherever we look about us we find the evidences of the copartnership between brains and business. The electrical industry today burns one-third less coal than five years ago, yet gives double production.

We now have fifty million horsepower, as measuring the productive capacity of the United States, or 425 H.P. for each thousand of population.

Wealth the Product of Brains

Go back, if you will, to elemental definitions of wealth, or to any school of economics; but we must recognize that wealth, collective or individual, is the product of brains; and labor is productive only as it is guided by intelligence.

We create tax-spending agencies and issue tax-exempt bonds in an orgy of financial exuberance. The outstanding issues of tax-exempt securities have increased so rapidly that they remind us of a visitor to Florida during the boom days, who, as the story goes, passed a vacant lot in the morning, and on his return that evening, found an apartment house erected, and the landlord already ejecting tenants for non-payment of rent.

The tax-exempt bond has its legitimate place in the realm of finance—but such issues, amounting to nine billions in 1918, to thirteen billions in 1922, and to eighteen billions in 1926, if continued, will in a few years more deprive all industry of available funds for expansion and development.

I mention this prodigality in tax-exempt bond issues, because in the natural development of industry, funds must be

constantly available with which to carry out involved processes of power and transportation, housing and merchandising. And the ease with which such issues may be floated, has encouraged municipal ownership, which is the advance guard of government operation.

In 1790 the per capita cost of government was $1.20 per annum. In 1923 we spent $31.80 per capita. As a government we are spending $24,000 a minute. So long as we ignore the fact that all governmental expenditures must be met out of taxation; so long as we pass fundamentally unsound tax laws which penalize industry or the proper accumulation of a surplus in business; so long as we permit the government to compete with private industry; just so long may we expect evasion of the law, and subterfuge in administration. Money and years of study spent in the development of an idea, are not recognized as invested capital and the return from a life of research is often taxed as the income of a single year.

Plant equipment and real estate may be valued at replacement cost; but who can measure the value of good will?

Evading Taxes

When France hunted for some new source of taxation, she hit upon a tax on windows as a method of taxing luxury. The law applied only to panes of glass opening into the walls of a building. Whereupon the architect Mansard designed shutters to open in the roof, thus evading the tax, and giving us the Mansard window of the present day.

There has arisen a group which subscribes to the theory that the sun of industry may be commanded to move or to stand still, by the Joshua of legislation, and that the water of plenty can be struck from the rock of industrial depression by the Moses of governmental operation.

In our wild-eyed efforts to be the legislative architects of Utopia, we have designed fantastic structures of legislation, and statutory monstrosities of regulation.

A recent safety council was called in Washington, D. C., and hundreds of high powered men were present. They agreed that automobile lights must not throw their glare higher than 42 ins., but they did not even discuss signs which the motorist is supposed to heed, placed 7 to 8 ft. above the roadway.

They argued long and learnedly about minimum and maximum speeds, and the removal of horses and mules from the streets to speed up traffic, yet they continue to advocate the construction of trolley tracks in the middle of the street, and the necessity for all traffic to halt whenever a street car stops.

We have made enormous strides in recent years in the solution of our social and economic prbolems. The commonest laboring man now enjoys electric light, heat and power, to say nothing of educational facilities for himself and his children, which were beyond the imagination of the richest man a few years ago.

So rapidly have we advanced that in many states the American working man's children of today study their lessons by electric light, and are carried to school in an automobile bus, fed warm lunches by a zealous parent-teachers' association, while the father of the family is protected by group-insurance, and the mother receives the cooperation of material welfare organizations.

The historic feasts of ancient Rome were eaten by the light of dirty oil lamps, without any chimneys.

This progress is not the result of legislation; it is the natural outcome of adherence to economic law.

The Beginning of Capitalism

Walker recounts in "The Things that are Caesar's" how two men in the Stone Age, hunted for days before capturing a fawn. Having satiated their hunger, the younger of the two dropped what remained of his half and went to a nearby stream to quench his thirst. The older, with the memory of his hunger still upon him, cached the balance of his portion high in a tree.

A few days later, again overcome with hunger, they retraced their steps. Arriving there, the elder proceeded to eat from his store, while the younger demanded a share. The skill and strength of the older man made it unwise for the younger to attack him, so he began to beg, saying, "When my hunger is satisfied and my strength renewed, I will go hunting and give you half of my next kill."

That, gentlemen, was the beginning of wealth, and its use the beginning of capitalism, while the hunting of the younger man to repay the debt he owed the older, to keep him from starving, was the beginning of the wage system.

Only the incompetent accepts with alacrity, anything that offers, because if he does not, there are a hundred behind him who will.

Yet the socialist insists that the solution of poverty is to tear our social fabric to pieces, and to equalize wages and opportunity.

We have but to view the unemployment dole and the coal subsidy in England, to grasp the utter folly of such uneconomic experiments.

The fallacies of Canadian Government Railway profits; and the Ontario hydro-electric situation need no further exposition at my hands. Socialism arrives, not alone by revolution, as in Russia, but through the insidious invasion of the government in business.

Taxes must be levied and collected or there will be no government. If all utilities were publicly owned, the cost of government would be no less, while taxes necessary to defray the expenses of government would have to be raised through other sources, for the taxes now paid by public utilities would automatically end. At present the public utilities of the country are contributing annually $700,000,000 toward general taxation, or about 25 per cent of the taxes paid by all the incorporated industries of the country.

The Envy of Every Foreign Country

There are today over seven and one-half billion dollars invested in electric light and power companies in the United States, with over two and one-half million stockholders, while millions of others have indirect ownership through savings banks and insurance companies. The rapid advance of the electrical industry in the United States is the envy of every foreign country. By it, the earning power of the individual is increased in direct proportion to the power development of the nation.

The advantages of private initiative in maintaining low costs and efficient service have no more striking exposition in the world than in the constantly increasing amount of light delivered per unit of cost by our great lighting companies. There never was a legislative body in existence that ever created a tax that was not eventually passed on to the ultimate consumer.

Capital is entitled to its just consideration. Every new process must effect a greater saving than the interest charges on investment. There must be a confidence that the investments so made will be allowed a "living wage."

Let us not mark on the tombstone of American industry, as might well be inscribed on that of Russia:

"Died of an overdose of theories and a shortage of bread."

The whole matter of granting police power by the addition of amendments to the Constitution, giving the Federal Government control, or of forcing states to adopt a system of inheritance taxes to satisfy Congress, is breeding indifference to law and destroying the sanctity of government itself.

Antiquated Laws

Only a few years ago the Georgia Legislature made the wearing of false hair, or the use of rouge a cause for marriage annulment.

We smile at the Blue Laws of Tennessee, under which the sheriff may not make an arrest for any cause on Sunday unless he has first attended Divine service; but we forget that it is still unlawful in Connecticut for a man to kiss his wife on Sunday; or in New Jersey to ride a train or a horse, a bicycle or an automobile on that day, except to attend religious service; while in New York, if a child or a servant dies as a result of chastisement by its father or master, the person inflicting the punishment is not even guilty of manslaughter. In still another state, if a woman has been divorced and marries again, and her second husband is not able to support her in the manner of life to which she has been accustomed, her divorced husband is required to contribute to her depleted purse.

Judge Emery of the National Association of Manufacturers in a recent address said:

"An average man can read the Constitution of the United States through in 25 minutes, but he can study it with profit the remainder of his life."

That Constitution grants seventy legislative powers and surrounds their exercise with one hundred and fifteen prohibitions.

Government Not a Business Agency

The Government was not created to engage in business, but to secure and insure safety and happiness. It is natural that every business agency should seek to increase its power, strength and domination, but the Federal Government, the worst offender in that respect, is not a business agency, and should not enter into competition with its own citizens.

For example, why should a government engage in the development of power projects for a cash return, with which to recoup expenditures for flood control,

irrigation and navigation, each of which is a government function not measured by the cost involved, when performed for the well-being and safety of its citizens?

Another attack on our intellectual leadership—on the inventive genius which has produced the machinery making possible mass production and high wages, comes from the disguised enemies of the backbone of our prosperity who, having failed by every other argument, bring up new issues to break down the tariff, to permit European counties to pay in goods, on the theory that payment in gold is impossible.

Instead of our trying to market our surplus goods in foreign countries, let us increase our consumption at home, where *already 90 per cent of our production is absorbed.*

We are a nation of sentimentalists. We like to think of the Italian peasant with his vineyard, the French housewife with a few francs hoarded away in a stocking, but as a matter of fact these countries have their large corporations analogous to the U. S. Steel and similar American organizations whose annual volume of business is greater than the total national debt.

These industries are endeavoring to borrow money with which to expand. Already private banking concerns in America have loaned a greater sum than the total European debt to the United States. And these bankers would like to see us cancel our national first mortgage in order to make their second mortgage more secure.

The Mainspring of Progress

How much better it would be for us to finance, not greater productivity, but better distribution, better facilities for internal consumption of their own products; better railroad equipment, an extended electrical industry which will bring a higher standard of living, peace and contentment. *Intelligent selfishness is the mainspring of all human progress.*

Rotarians exemplify this thought in their motto, "He profits most who serves best." The service of the electrical industry to the prosperity of America can only be reckoned in terms of millions of manpower. The farmer of tomorrow will be the master of a thousand slaves, while the housewife of today rules a kingdom of mechanical servants.

The mechanical development of industry, operating under the immutable laws of economics, has changed our marketing systems: buyer no longer hunts seller; high labor cost must be liquidated in production; service, quality, and price, are the masters of commerce. To attempt their control and their diversion by legislation is as futile as the Missouri law that "all hickory bark shall peel in January, in order that our farmers may utilize the winter months in basket making."

We see about us an epidemic of legislation and reform.

A reformer is a man who can solve anything without thinking; an egotist anaesthetized by Nature to allay the pain of being a fool.

All of the legislative reforms of recent years find their counterpart in ancient history. Minimum wage laws, farm relief, price regulation, each has had its day. Child labor is uneconomic and therefore doomed.

Daniel Webster on the Clamorers

Go back to the days of Daniel Webster, a century ago, and read his speech in the Senate:

"There are persons who constantly clamor. They complain of oppression, speculation and pernicious influence of accumulated wealth. They cry out loudly against all banks and corporations and all means by which small capitalists become united in order to produce important and beneficial results. They carry on mad hostility against all established institutions. They would choke the fountain of industry and dry all streams. In a country of unbounded liberty, they clamor against oppression. In a country of perfect equality, they would move heaven and earth against privilege and monopoly. In a country where property is more evenly divided than anywhere else, they rend the air shouting agrarian doctrines. In a country where wages of the laborer are high beyond parallel, they would teach the laborer that he is but an oppressed slave."

What we need is an awakened citizenship to express its enlightened wish at the polls. So long as the taxpayer avoids jury duty and active participation in the right of suffrage, he has little ground for complaint about the country's administration. If a vote is worth fighting for, it is worth using.

Let us permit no rainbow theory to lure us into inactivity. Let us not become thrilled by political sleighbell ringers announcing a Santa Claus form of government. The reign of the demagogue is the product of the citizen's apathy.

"Business gives work to labor's countless hands; business wipes tears from the eyes of widows and orphans; business dimples with joy the cheek of sorrow; business covers the land with happy homes."

He Who Has Vision

Like the Pharaohs back of the Pyramids; like the engineers behind the Panama Canal; like Steinmetz and the host of scientists who have given us the great developments of today, there is always the human intellect, superior (in my judgment) by Divine intent, to the rabble who would destroy that which they are incapable of producing.

ROAD DEVELOPMENT FOR NATIONAL DEFENSE

By Edward K. Smith, Captain, Corps of Engineers Reserve.

(From "The Military Engineer" for July-August, 1927.)

An easy attitude regarding national defense is to rest in the sunshine of a rosy future and ignore the knowledge that was forced upon us ten years ago. To their credit, be it said, some men in civil life have not forgotten that experience. The American Legion, the Reserve Officers' Association, and other civilian organizations still urge the necessity of maintaining a suitable preparedness in organized man-power, capital, and industry to meet a national emergency efficiently and economically. True, it costs money, but organized preparation for national defense is no more than national fire insurance against an international conflagration.

Plans have been carefully prepared for the mobilization of men. Most Reserve officers are familiar with them and have worked upon them. Other plans have been prepared for the emergency mobilization of industries and railroads, within the "procurement districts." These are largely the province of the Quartermaster Corps and of the Ordnance. A large part of the military engineer's duty deals with roads, and it is of special interest to him to know what provision is being made for the industrial mobilization of the highways of the United States. To quote Lieutenant Colonel Marshall R. Pugh, "The highway is the fundamental avenue of army transportation, just as it is of transportation in civil life."

Roads From a Military Point of View

From a military point of view, roads may be broadly divided into two classes, those in the zone of the advance which may be under enemy fire, and the roads in the zone of the interior, not subject to deliberate destruction. To lay out, reconstruct, and maintain the road system in the zone of the advance are major duties of engineer troops. They may be trained for this duty in time of peace, but the real work can not come until the emergency arises, until the theater of operations is known, and until the zone of the advance is defined. Military engineers usually feel that their interest is limited to these roads; but the more permanent roads in the zones of supply and of the interior are also of great value and importance, and should be studied by the military engineer.

In time of national emergency, fire, tornado, earthquake, or war, all means of transportation are used to the utmost. Inability of either rail or road to function throws greater burden on the others. In military operations, men, equipment, and supplies are constantly moving forward toward the front. Back from the zone of the advance come men to hospital and rest areas, and transport to refill at base supply points. In the zone of the interior, men are being concentrated by the hundred thousand in training areas. Raw materials are hurried to mills and factories; food, clothing, equipment, and munitions are being rushed out of industrial centers in enormous quantities. The railroads are best adapted to serve long hauls. Motor trucks and busses on the highways serve for quick concentrations and short-haul traffic, up to 100 or 200 miles, and relieve the railroad main lines of the interference from this local traffic.

Men overseas in 1918 and 1919 will remember the highly developed and improved French road system and the great use made of the highways by American transport. Engineers, in particular, will recall the great amount of work performed by labor battalions and prisoners of war in repairing the roads around the American camps and the main supply routes through the S. O. S. After the armistice, during the first five months in 1919, American troops repaired and maintained 10,000 kilometers of French roads, damaged by American traffic.

As one result of their war-time experience, the French realized the difficulty of maintaining a water-bound macadam surface under heavy traffic. Since the war several parties of French engineers

have visited the United States to inspect and study our hard-surface roads.

The French roads, 420,000 miles, in a country only four-fifths as large as Texas, have been developed during hundreds of years. In the United States we have a country fourteen times the size of France, 3,000 miles across, with our industrial and food supply centers widely separated and with nearly three million miles of roads. Nearly all of our present-day system of improved roads has been improved since 1900, and a very great percentage during the last ten years. Today, in 1927, about 7 per cent of the total road mileage of the United States has been surfaced with macadam or higher types of surface.

War Transportation Experiences

Our experiences with transportation in the United States during the World War were illuminating. We were 3,000 miles away from the theater of operations, yet both rail and road in the United States were terribly congested. The national government, as a war-time necessity, took over the administration of all railroads.

In 1917, we had almost 100,000 miles of hard-surfaced road, as against 190,000 miles today. But, in 1917, we had only 5,000,000 motor vehicles operating on the roads, as against 20,300,000 in use today.

In 1917, it was at first felt that highway improvement was not a necessity and should be postponed. In a very few months, the improvement and maintenance of highways were found essential to the war industries themselves. All transportation facilities were strained. It was found that motor trucks operating over an 18-ft. road could handle a greater tonnage than a single-track railway equipped with the usual siding capacity. The Highway Transport Committee of the Council of National Defense was organized, "to conserve and strengthen every element of highway transportation." In Indiana and other states, the councils of defense urged their citizens to use roads for short-haul transportation and relieve the railroads for long-haul traffic. Thousands of men were hurriedly building roads to cantonments, camps, supply depots, and concentration points. All this to meet the necessities of a war 3,000 miles away. Trucks moving from Buffalo to Newport News for shipment overseas were lost for days, hub-deep in the mud of inadequate roads.

General Pershing, before the Senate Committee on Roads, stated in 1921, "The country road will be of tremendous value in time of war . . . the roads must be relied upon to obtain the needed food supplies."

With our shortcoming fresh in mind, the National Defense Act was revised in 1920. This act did not provide in detail for emergency mobilization of railroads and industries. It provided, however, for coordination of all procurement work, including planning therefor. With the cheerful cooperation of the industries themselves, such plans have been made. They can best be explained by those who have worked on them. We have three million miles of roads, 7 per cent improved with hard surface. What provisions have been made to render our roads fit for service in a military emergency? The building of thousands of miles of roads can not be taken up overnight. After years of preparation and building up the necessary organizations, we are placing hard surface on less than one-half of one per cent of our highway mileage each year.

Twenty years ago, our road-building was unsystematic. Most of the road improvement was carried on by the local authorities, town and county, on a small scale. Stretches of improved road were blocked by unimproved sections, often impassable. A few states, however, had laid out state trunk highway systems, and, through state aid and the supervision of state highway commissions, were encouraging systematic improvement. The recently organized United States Bureau of Public Roads was making some studies of highway improvement in behalf of the national interests.

The Federal Aid Act

The greatest single element in the real development of a serviceable road system for the United States was the Federal Aid Act of 1921, passed by the same Congress that gave us the National Defense Act. Under this act, a limited percentage of through routes might be approved as federal aid roads. If requested by the state, a limited amount of federal aid money will be contributed to the cost of these roads if the federal standards for construction are complied with. The maximum aid provided in the act of 1921 is one-half of the cost of the road and not over $20,000 per mile. Not over 7 per cent of the total road mileage in any state may be included in the federal aid system. The total federal aid money spent on roads last year was only 7 per cent of the one billion dollars spent in

the United States on road improvement. We still have in the United States 2,250,000 miles of roads with little or no improvement. How is road development for military use provided for?

We are proud of the constitution we have sworn to defend. We should also be proud of the National Defense Act of 1920. In future years it will be regarded as a most valuable piece of constructive legislation, providing for nationally organized defense, without militarism and not for aggression. It is not in accord with our policies, as expressed by this legislation, to appropriate money for a large military establishment. Our policy is rather to give every patriotic citizen, in his civilian pursuits, opportunities for elementary military training and organization, that all may be prepared to function efficiently, if the emergency arises.

Similarly, the spending of large amounts for the peace-time construction of military roads is not in line with our policies. But, in most cases, these roads which best serve our normal industrial development are the same roads that will be needed in time of emergency, military or otherwise. The main highways join our industrial centers. Their feeders tap the sources of supply in mine, forest, and farm. This has been our development for a hundred years. John C. Calhoun, Secretary of War, reported to Congress in 1819, "The road . . . can scarcely be designated, which is highly useful for military operations, that is not equally required for the industry or political prosperity of the community." General Pershing's testimony, one hundred and two years later, has already been quoted.

Relation of Bureau of Public Roads and War Department

The vital factor, to secure the ready development of a road system, fit for use in a military emergency, is some central agency to assist in coordinating the scattered efforts of forty-eight states, to set minimum standards for economic, serviceable construction, and to give due consideration to the broader, national interests, outside the province of a single state.

Under our present law, the United States Bureau of Public Roads exercises this function. It is neither practical nor desirable for our overburdened Regular military establishment to attempt to work out details with forty-eight states and thousands of counties. The military value of a road is only one of many factors in its construction. The Bureau of Public Roads is furnished all necessary military information from the Office of the Chief of Engineers. The minimum width of 18 ft. for a federal aid road is satisfactory for two lines of military traffic. Culverts and bridges are designed with a clearance of not less than 16 ft. between side walls and 14 ft. vertical. They are designed to carry, with the ordinary factor of safety, two 15-ton, or one 24-ton, truck. This gives clearance and strength sufficient for a 155-millimeter gun or a heavy tank. At the same time, these requirements are reasonable for civilian traffic. Paving is designed to carry as continuously heavy traffic as can be carried by the bridges. Grades are limited, whenever practicable, to 7 per cent.

The War Department has prepared maps of the United States, indicating those points between which roads are of military importance. These maps do not attempt to define the exact route to be followed in connecting two points or two cities. Several routes may be available; which one will be followed is largely dependent upon local conditions.

Engineers will readily recognize the military values of the road systems shown diagrammatically on the War Department map. Naturally, these roads in most cases can follow normal industrial routes and were readily incorporated in the complete system of federal aid road approved by Congress in 1921. These military maps also indicate the relative importance to the Army of the connections between cities as of first, second or third "priority." The roads corresponding to "first priority" connections should receive first attention, and, as occasion arises, this is being done. While progress is being made on the entire system, a special effort is usually made by the federal authorities to persuade the states to fill in the gaps of the "first priority" system and make it fit for use. There are over 16,000 miles of so-called first priority roads (roads between points whose connection is considered of first priority). Only a small amount of this system is completed each year. It will be several years before even the first priority system is completed, but steady progress is being made. Some of the priority roads are, of course, improved as parts of state or county systems.

Function of Bureau of Public Roads

Except in the case of federal aid roads,

the authority of the Bureau of Public Roads is purely advisory. Even in the case of federal aid roads, the initiative rests with each state. But even the small amount of money which is appropriated as federal aid (in 1926, 7 per cent of the total expenditure in the United States for road improvement of $1,000,000,000) enables the Bureau to enforce to a considerable extent the use of their standards, and, in a general advisory capacity, to assist in the development of the lesser road systems for their national services, mail routes, interstate through traffic, and military use. It is also true that, in some of the Western States, with large areas of undeveloped, or government-owned, land, through roads could not be built without this federal assistance. The opening of the "Wendover Cut-off," across the state of Utah last summer, is an instance. It may also be said that the adoption of these standards on federal aid roads in every state in the Union has greatly encouraged the adoption of corresponding standards on other road work within the state.

Development of Arteries Into Cities

Another important feature of road development lies in the particular development of the streets and highways leading into large cities. Just as a railroad line must have proper terminal facilities in order to give adequate service, so our major highways can not be used to their fullest extent without proper entrances and terminals at the large industrial centers. The great congestion and delay that occur at the main highway entrances to a large city are well known to every driver.

In the last two years, cities have recognized that this problem concerned not the city alone, but also the surrounding suburbs and nearby centers tributary to the city. Plans for the development of the region tributary to the city are prepared or are in the process of preparation for such centers as Detroit, Boston, Los Angeles, and Chicago. Many other cities need them. This work is being handled by local authorities. The military engineer will readily see, however, that this "regional planning" around a city like Chicago may be of importance to the nation as well as the city.

Roads a Defense Factor

Recently, the Corps of Engineers has adopted a new system of indexing geographical information. The Harriman Index number exactly defines the geographic location of any area. It has been planned by the road authorities to place on certain cross-country routes federal numbers and markers of special design, spaced at regular intervals. It has been suggested to the officials in charge of the design of these markers that, if provision were made for placing on each marker, in small, inconspicuous figures, the index number of that spot, it would be of great value in military operations. Even for touring, these numbers would be useful to the half million members of the Regular Army, National Guard and Organized Reserve, as they become acquainted with these new maps.

Our scheme for national defense is still in the process of development. Without continued, vigorous support, to maintain public interest, it will fail, as have such movements in the past. The development of an adequate national road system during the next ten years, to reach every city of five thousand population, will be one factor in our scheme of national preparedness.

The movement is under way, the machinery is functioning. After ten years' work, 19,000 miles of the federal road system have "high type" surface, concrete, brick, sheet asphalt, and so on, completed or under contract with federal aid. In addition, over 16,000 miles have received "high type" improvement without federal aid. Of the remaining 148,000 miles, 50,000 miles, or one-third, have had no improvement, and 28,000 more are dirt roads, graded and drained. The remainder has various types of light and "medium type" surface, running from sand and gravel to 16,000 miles of water-bound and bituminous macadam. A large part of our military road system, of first, second and third priority, is included in the 148,000 miles only partially improved. The movement to improve any road must be started within a state and receive local support to secure the appropriation of state and local funds for their share of the construction cost. The military engineers are especially fitted to give the intelligent support to this program that is needed to carry on the work successfully. They, above all others, realize that the roads built during our years of peace and prosperity must serve as our military roads in time of emergency.

Local posts of the Society of American Military Engineers may perform a most valuable duty by appointing special committees, composed of men trained in highway development, to study the road problem in their vicinity. This study

should consider the location and character of strategic roads, terminal facilities, and means of increasing capacities in event of an emergency. This committee should be a continuing body, keeping its mediately available.

MOTOR VIEWS ON HIGHWAY RESEARCH

(From address by Pyke Johnson, of National Automobile Chamber of Commerce, at Highway Research dinner, sixth annual meeting of Highway Research Board.)

Your chairman has suggested that you may be interested in the motor viewpoint upon these highway problems. Because, as a great writer has said, that it is not the asking of a question which is embarrassing, but making an answer, I have assumed for the moment an executive prerogative and have asked some of the leaders of the industry to state for you what is the chief problem in motor transportation which demands the attention of the research investigator.

The first response which comes to mind is that of Roy D. Chapin, known to all of you as chairman of the Highway Committee of the Chamber.

Mr. Chapin's answer is: "No problem in the entire field of highway transportation is of more far-reaching importance than the human one of further safeguarding the lives of those who use our highways. No sound effort directed along these lines will be wasted."

In the field of physical research, Mr. Chapin suggests a need for a further study into our city street facilities. Many of these have shown signs of failure under the thrust of a growing traffic while our rural roads are standing up.

By way of further comment, it might be said that the practice of digging up streets as soon as they are laid for connections of one sort or another is deserving of much more public attention than it has generally received.

From John N. Willys comes a suggestion for research within the industry itself, as follows:

"In my opinion the outstanding problem in motor transportation to be solved by research is a higher fuel economy coupled up with elimination of the gear shift and uniform laws on headlights."

H. H. Rice, who has twice fared forth into international fields as a member of official American road delegations, looks upon the subject of city office building in its relation to street capacity as one of the most outstanding of all the problems connected with motor use. With that, of course, he suggests the corollary of studies into the incidence of decentralization.

From Alfred H. Swayne, chairman of the Committee on Motor Transportation, Conference of 1923, comes this word:

"I believe that more scientific management of traffic and relief of congestion in our great cities is an important problem to be solved."

F. J. Haynes, who has been particularly close to the problems in Detroit, but whose grasp of the subject is national, wires as follows:

"Automobile production methods should be adapted to highway building to lower the cost of the product. Increased durability is also needed in order to decrease taxation per mile of construction and to permit greater economy in vehicle use which will come from redesign of size of vehicle, its method of construction and more efficient fuel consumption. Road construction should be wide enough in the first instance so that immediately upon completion, or shortly thereafter, the work is not completely doubled in cost because of doubling in width. In the building of expensive viaducts or grade crossings, they should be made wider than the road so that should the road be widened the grade crossing will be wide enough, since it is easier to widen the road than to increase the size of grade crossings."

From Alvan Macauley, who has presided over, or been a member of, many committees on city planning, comes the terse comment:

"Outstanding problem in transportation is still parking of cars in downtown areas," which carries with it the implications of extended research into the causes and effects of traffic movements.

Edward S. Jordan, of the Traffic Planning and Safety Committee of the Chamber, wires:

"Highway Research Board should favor national movement and organized national conferences of mayors, city managers and engineers of all big cities to institute research and formulate plans for increasing floor space for transportation. Great problem is to impress officials and property owners with economic necessity of this action."

Finally, there is a comment from A. J. Brosseau, of your own board and a

recognized authority on highway transportation:

"We must determine new ways of securing the utmost use from highways constructed by the public. Present day routes will not long be adequate to care for the intensive movement in greatly congested areas. Officials in charge of metropolitan area improvements have this question to consider: Which is the better public policy in the long run, the construction of highways with bottle necks such as constant street intersections, inadequate bridges and with obstacles stemming the flow of traffic, all adding greatly to the cost of the movement, or the building of trunk line roads, by-passing congested centers and separated from other means of communication."

These questions having been answered by the motor industry, there are a few I should like to ask of you, to round out, what after all, can only be a high-spot commentary: If city transportation is one of the principal problems and as you have heard, it is so considered by motor leaders, what can be done to improve it? Are we going to maintain our present system of diversified types of vehicles, some traveling on rubber, some on rail, some above the street, some below, or is further simplification possible?

When one hears it said that all forms are necessary, the question comes to mind as to whether the statement is not based on the present day bus.

No immediate answer is suggested, but into this question comes the research man, both that one engaged in the factory and he who is studying street planning and traffic trends, as well as the city administrator who is charged with the responsibility of seeing that the public obtains the most efficient use of the transportation facilities which it has purchased.

HIGHWAYS AND THINGS LIKE THAT

By Col. Helz Belz, in Louisiana Highway Magazine.

Highway engineering is the science which enables restless souls to get elsewhere with the least possible delay, and in the most comfortable manner. It builds the proving ground for the damphool, and the shortest route to the happy hunting grounds. It also provides the playground for the merry game of "Who's who at the railroad crossing."

The modern highway is the breeding place of bond issues, mortgages, dust, discourtesy, speed cops, lawsuits, petting parties, hi-jackers, detours, cock-eyed drivers, and other parasites of polite society. It is the farmer's necessity and the city dweller's Sunday afternoon.

The Romans, so history tells us, built roads in every direction from their capitol. Most of them, however, were built in a horizontal direction, in order to enable Caesar's curio collectors to get their plunder back to Rome before the other fellow got organized to retake it. From their traffic regulations we get the first tip on one-way streets, as we are advised that all roads led to Rome, though every one who has visited that city is very much surprised that they were able to accumulate so much junk in only five or six centuries.

In considering the road-building exploits of the Egyptian, Carthaginian, Babylonian, Roman, and other engineers of the bee see period, we are led to wonder if these ancient dirt movers had anything on us highway experts. While many of our highways do not outlive the bonds that financed them, some of the Roman roads are still live projects after two thousand years. However, history offers no answer as to what the result would have been if they had had to build them with Federal aid.

An editorial in the "Roman Candle," written by Heroditus informs us that Cheops used one hundred thousand men for ten years on the construction of Egyptian State Aid project No. XVIIICM. Any modern engineer who submitted a project like that would find himself in psychiatric cold storage before the ink goes dry on the project statement. Our projects may be shy on lasting qualities but we know something about first costs anyway. And we know how to get a job done before the resident engineer has had time to wear out more than two Fords on it.

The Appian Way, also a state project, could not now be built for less than $250,000 per mile. Incidentally, it has been resurfaced since the Italian equivalent for the flivver made its appearance. For that price we could build a road that would make old Appius Claudius kick the concrete lid off his mausoleum from sheer envy. Just imagine a road surface three feet thick and thirty feet wide, with side walks, electric lights,

comfort and filling stations every half-mile, hot dog stands and furlined receptacles for coco-cola bottles every sixty-six feet!

It is a funny thing that every goat who tries to get off a few remarks about highways always harks back to the achievements of some foreigner, when, as a matter of fact, one of the oldest known roads is on the American continent. It was built so long ago that the final estimate had to be chipped off the stone slabs that the Ten Commandments were written on. It was nearly two thousand miles long, and was built by the Incas from Quito to Cuzco in the Andes. It was surfaced with stone blocks twenty feet wide and ten feet thick, and had shade trees and a running stream on each side. Most of it was at an elevation of somewhere around twelve thousand feet above sea level. This emphatically disproves the assertion that road materials are higher now than they used to be.

PRESENT PAVING PRACTICE IN NEW YORK CITY

By R. A. MacGregor, Engineer of Maintenance, Borough of Manhattan, New York, N. Y.

(Address before the Engineers' Club of Philadelphia.)

While speaking principally of conditions in Manhattan, I have been enabled to get some data from the other Boroughs of New York City.

The total mileage of paved streets in New York is between 2,100 and 2,200 miles with an area of 42½ million square yards.

The traffic conditions vary from the lightest possible, a few delivery vans per day, to the most intense, or at least as intense, as any in the United States.

The subsurface conditions also vary as might be expected, but generally owing to the established practice of building sewers and laying water mains by the city and the construction to a considerable extent of duct lines, before the paving is done, the roadbed is well provided with drainage. This eliminates any general disturbance from freezing, which in many localities works serious damage to both concrete foundation and wearing surface.

The standard foundation for pavements is concrete 6 ins. thick. This is required for pavements to be classed by the Board of Estimate and Apportionment as permanent and for which the abutting property having been assessed cannot be asserted for subsequent repaving.

Pavements with foundations of less than 6 ins. of concrete are classed as temporary and the cost of these is assessed as well as the cost of the subsequent repaving, the property, however, being credited with the payment made by the first pavement, thus in theory at least, the property in New York City is assessed only for the first pavement.

As concrete foundation 6 ins. thick, in this way, is considered the standard, practically all the pavements laid as first pavement have 6 in. base. The Borough of the Bronx still holds to this thickness. The Borough of Brooklyn does also. I believe the Borough of Queens lays concrete foundations 6 ins. thick, but a speaker from Queens is here, or expects to be, and he will speak for that borough. The Engineers of Brooklyn and the Bronx state that 6 ins. thickness has been found sufficient and there is no intention to at present increase the thickness.

In Manhattan practically all streets are now paved, less than 10 miles out of 490 being still unpaved. In repaving 6 ins. is still the usual thickness, but where traffic is heavy and likely to increase both as to wheel loads and to density 9 ins. foundation is used.

In nearly all streets repaved, dust lines and gas mains have been laid or repaired just ahead of repaving, thus making the sub-grade a series of recently filled trenches. To take care of this situation, the foundation is made 9 ins. thick on streets with heavy traffic loads at the present time, or expected during the life of the wearing surface and about 22 miles have been so laid in 1925 and 1926. In other cases, the foundation is as thick or even thicker, due to changes of grade and the placing of additional concrete to bring the new pavement to proper grade and crown.

A study of the relative costs and value of increased thickness of plain concrete and of reinforced concrete was made some time ago by the Department, for the purpose of deciding on a policy.

It was found that 9 inches thickness of pain 1-3-6 concrete would give more than double the strength of 6 ins. at a cost of 50 per cent increase; that a 4 in. thickness reinforced would give nearly

three times the strength of 6 ins. plain at less cost than 6 ins. plain concrete; that a 6 in. thickness properly proportioned reinforced would give nearly 7 times the strength for a 25 per cent increase of cost.

These results as to cost would vary quite considerably in other locations due to lower labor, transportation and disposal costs. In Manhattan practically all excavated material has to be disposed of by loading on scows and dumping at sea, or for filling in under water around the harbor. The price of the dumping runs about $1 per cu. yd.

Transportation costs are also high, due to congestion at the loading piers and the price used in the calculation mentioned, $4 per cu. yd. of excavation was not at all extravagant.

Another consideration is the difficulty of making and restoring cuts. While the labor and cost of replacing reinforced concrete would be increased, the result would to a large extent be a stronger slab over the cut without any better connection to the adjoining old concrete. The settlement of backfilling would still allow the new slab to sink.

The calculations mentioned were based on a uniform safe load on a 6-ft. span. Such a span is quite often found; cases of much greater span up to 13 and 14 ft. over cavities large enough to stand up in have been found and this with old 6 in. concrete.

With the modern methods of mixing and better inspection our 6 in. foundations have improved though perhaps not as rapidly or as much as the amount of traffic, and to get rid of the annoyance and interruption of traffic, the use of 9 in. concrete was begun for streets as outlined above.

I might say that our records for cave-ins (as we call them) which require restoration of the concrete foundation may not justify the increase to 9 ins., a great many settlements are taken care of by adding to the depth of asphalt pavement or by adding to the bed in granite pavements, while repairs are being made.

The practice in Manhattan is to repave over openings as soon as possible after backfilling. This is done generally within 10 or 12 days, the concrete being laid 2 or 3 days sooner and immediately opened to traffic with only 3 or 4 ins. of earth on top as protection. It is only very rarely found that the concrete is not set up sound and hard when cleaned off for asphalting. Examination of settlements over trenches also shows in most cases sound, hard concrete, with a settlement of the slab following the sunken backfill.

The policy has been to get as nearly as possible the full value out of the cement and changes have been made in the specifications from year to year following experiments showing improved methods.

Batch mixers have long been required, greater care in measuring the aggregate by the use of standard wheel barrows because measuring boxes are not practicable; now most of the aggregates are measured as they are loaded into the trucks. The latter having partitions and the required quantities of coarse and fine aggregate for one batch are loaded into each compartment from overhead bins. The cement is usually delivered separately on the street and the proper number of bags added to the hopper after the batch of aggregates has been dumped into it from the truck.

Another recent advance in the specifications is the fixing of the amount of water to be added to a batch for each bag of cement used. This is in line with recent tests made by cement experts.

The average age of pavements at date of replacement is now about 26 years for granite blocks and 18 for sheet asphalt. About 500,000 yds. of granite and 600,000 yds. of asphalt laid before 1900 are still in existence and of this about 215,300 sq. yds. of granite were laid before 1890.

IMPROVED COUNTY GOVERNMENT IN NORTH CAROLINA

(Editor's Note: There is much discussion of our national government and of state and city government, but county government is seldom mentioned and it undoubtedly is the poorest government we have. Just why it has so long escaped critical attention we are at a loss to understand. Perhaps improvement is coming if we may judge from the following article from the "National Municipal Review.")

By a series of three laws passed at the recent session of the Legislature, North Carolina places herself in the van of the states which are doing something

about county government. It is now possible for counties in that state to choose between two forms of government—the regular form now existing and the county manager plan. It is possible for the county commissioners themselves to install the latter plan on their own motion, but if the county board does not exercise its discretion to appoint a manager, the electors may by petition bring the matter to a vote. If the majority of the votes cast at the election are in favor of the manager plan, the board must proceed to appoint a manager.

The manager is empowered to appoint, with the approval of the commissioners, such subordinate officers as the board may consider necessary, except such officers as are required to be elected by the people or whose appointment is otherwise provided by law. But inasmuch as the act does not disturb existing elective or appointive offices, the appointive power of the manager will have a narrow range inconsistent with his position as "the administrative head of the county government" and his responsibility "to see that all orders, resolutions and regulations of the board of commissioners are faithfully executed."

A novel feature is the creation of a county government advisory commission, the secretary of which is to act as county adviser. In this capacity he will visit the counties of the state to advise and assist the county officers in providing competent and economical administration. The development of this office will be watched with interest in other states.

A second bill relates to county fiscal control. The county auditor becomes the county accountant, and as such, the chief accounting, auditing and budget officer of the county. The budget estimates of all department heads and officers in charge of spending money are filed with him and he thereupon prepares his own estimates of necessary appropriations for the ensuing fiscal year. The county board then determines the appropriations for the next year, but no appropriation recommended by the county accountant for debt services shall be reduced, nor can the county commissioners make any appropriation which will infringe upon the powers of the county board of education. It is also compulsory upon the commissioners to appropriate the full amount of all deficits reported in the estimates which have not been funded as provided by aw.

The third act relates to the issuance of county bonds and notes. It specifies the purposes for which bonds can be issued and limits the term of the bonds to the estimated life of the improvement as set forth in the act. All bonds are to be serial in form and no annual installment shall be more than two and one-half times as great in amount as the smallest prior installment.

The new county bond law is more comprehensive than any which has come to our attention, and applies to counties the sound principles which shall govern borrowings and which have been adopted for municipalities in a few states, notably North Carolina and New Jersey.

DEMAND FOR UNIFORM TRAFFIC ORDINANCE

Secretary of Commerce Herbert Hoover, who presided at the two National Conferences on Street and Highway Safety, which were held at Washington in 1926 and 1925, has been requested to consider the advisability of calling another gathering, to be held in the Middle West. This suggestion has been made by the various organizations that participated in the First Annual Central States Safety Conference which was held in Kansas City, Mo., in April. Resolutions passed at that gathering express appreciation of the leadership of Secretary Hoover and urge the preparation of a uniform traffic ordinance to supplement the Uniform State Code. It is the feeling of the twenty different associations which took part in the recent Kansas City conference that there is a great need for improvement motor vehicle legislation in the Central West.

The resolutions state, in part:

The traffic laws of the Central States should be made up-to-date and uniform so far as practicable. To this end, the Uniform Vehicle Code promulgated by the National Conference on State and Highway Safety, known as the Hoover Conference, should be adopted. We commend the states which have this year adopted portions of this code, and we urge upon the lawmakers and citizens of every state renewed activity looking toward the enactment of this Code at their next leigslative session.

In particular we reaffirm our conviction that all motor vehicle drivers should

be licensed as provided in the Uniform Vehicle Code.

A uniform traffic ordinance conforming to the Uniform State Code should be prepared and should be adopted by every city throughout the region.

To insure that all our preventive efforts shall be based on accurate knowledge of the facts, complete and accurate accident reports should be secured and compiled in every city and state along lines recommended by the National Safety Council.

Engineering studies of the traffic and accident problem should be made in every community. The installation of traffic signals and other control measures should be based on engineering study and not on whim or guess work.

We believe that in general the police departments and courts are enforcing traffic laws just as strictly as public opinion will permit, and we call on all good citizens to uphold these public agencies in the enforcement of laws which are so essential to the public safety.

We commend the splendid work which has been done by many school departments in the safety instructions and training of children, and we urge similar activities in every school.

The efforts which have been made by railroads, public officials, safety organizations, civic bodies and others to reduce grade crossing accidents are to be commended and should be continued.

Education in safety is needed by adults as well as children. A continuous program of public education should be carried on in every state and community through newspapers, radios, public meetings, posters and other methods.

To carry on these preventive measures in an orderly and effective manner every state and every community should be organized for safety and such organizations should include all interested groups and individuals, both official and unofficial.

Among the organizations represented at the recent Kansas City conference were the Kansas City Safety Council, Kansas City Chamber of Commerce; the National Safety Council, American Railway Association, American Electric Railway Association, the Portland Cement Association, Missouri Association for Street and Highway Safety, Kansas City Safety Council, St. Louis Safety Council, Kansas City (Kansas) Safety Council, Association of Operative Millers, Associated Industries of Missouri, National Electric Light Association, National Association of Taxicab Owners, National Association of Ice Industries, Kansas City Team and Truck Owners Association, Kansas City Oil Men's Club.

A GAS-ELECTRIC LIFT BRIDGE

The gas-electric lift bridge built by the Pennsylvania Railroad across the Chesapeake and Delaware Canal during the past year was officially put in operation March 15, 1927. This is a railroad bridge over which will travel steam trains running on the Delaware Division of the P. R. R., whose terminals are Philadelphia and Cape Charles.

The new bridge is of the vertical lift type and is located at a point 18 miles south of Wilmington. Previous to the present installation a small swing structure was used but, because of the widening and deepening of the canal and the consequent passage of large boats through it, a bridge of the lift type was found desirable.

At the time the change-over was made, the location was remote from electric power lines, and gas-electric drive was decided upon as being the cheapest meth- of of operation. Complete electrical equipment was furnished by the General Electric Company for this purpose.

The 110-kilowatt gas engine driven generator sets and exciters are installed in the operator's house on the shore, together with a switchboard and necessary contro devices. Two 120-horsepower motors, to operate the bridge, are located in the machinery house on the bridge itself. Flexible cables connect the motors to the power supply on the shore.

Each of the motors is of sufficient capacity to operate the bridge alone, and one of the generating sets is to be held in reserve as a spare. The equipment is so arranged that any combination of generator, exciter and motor can be used.

To open or close the bridge, the gas engine is started first, as the intervals between operation are too long to make continuous running of the engine desirable. By means of a selector switch, the operator next chooses the combination of generator and exciter he will use. The third operation, utilizing manual control, starts the motors, putting the bridge in motion. At the "nearly open"

or "nearly closed" position, a limit switch shuts off the power and, to complete the motion, the limit switch is short circuited by a push button and the bridge jogged along to the "fully open" or "fully closed" position.

The bridge itself is of steel construction, built by the Phoenix Bridge Company. The two piers are of stone, reinforced with concrete. The total length of the bridge is 419 ft., and the height of the towers from the ground is 149 ft., 6 ins. In the closed position the bridge is 50 ft. above the water and, when open, is raised 90 ft., or to a point 140 ft. above the water. The bridge carries two tracks and is 37 ft. wide. The lift span weighs approximately 700 tons, and the time required to lift the span to the full clear position is 90 seconds.

PUMP CONTROL FOR FIRE SERVICE

Two motor-operated pumps with a special arrangement of contol provide water at low pressure for ordinary consumption, and at high pressure for fire fighting, in the town of Jefferson, Texas.

Jefferson is located between a flowing well and pumping station on the one side, and, on the other, a water tank from which the town receives its normal water supply by gravity. Under normal conditions a comparatively small pump fills the water tank from the reservoir at the flowing well. Under fire conditions a high pressure pump supplies water directly to the town mains.

The pumps are electrically operated and controlled, General Electric Equipment being used. The service pump is of 75 g. p. m. capacity, working against a 104-foot head, and is driven by a 5-horsepower, squirrel cage motor. This motor is controlled by an enclosed magnetic switch which, in turn, is operated by a pressure governor. A protective float switch automatically shuts down the motor under low-water conditions at the reservoir.

The fire pump is driven by a 50-horsepower motor and has an output of 500 g. p. m. against a head of approximately 200 ft. This is controlled by a push button at the fire station. The push button operates two relays. One relay operates a remote control automatic starting compensator at the pumping station and the other, a contractor which energizes the solenoid of a hydraulic gate valve equipped with a solenoid-operated pilot valve.

Thus, when a fire alarm is given, an operator at the fire station depresses the push button which starts the fire pump and closes the gate valve at the foot of the water tank. Thus the fire pump delivers water directly into the mains at high pressure. When the fire is over, a "Stop" button is depressed and the fire pump stops, the valve opens and the service pump again picks up the load.

The installation was made by the Smith and Whitney Company, Dallas engineers.

LIMITATIONS OF MECHANICAL CONTRAPTIONS

Prof. A. E. Kennelly of Harvard University, in speaking before the American Association for the Advancement of Science last December, made the following comments on modern material progress:

"The advancement of science and of engineering have thus far always enriched mankind materially. Material production has been greatly hastened, so that the average possessions of men have been increased, or else larger populations have been supported to divide the increase. It is doubtful, however, whether increase of human happiness, beyond a relatively small modicum of possessions, is at all commensurate either with the growth of material wealth or with the growth of population. It seems that while science can largely increase general comfort and prosperity, it can, at present, ensure but little increase of happiness and contentment. Whether this must always and inevitably be so, is debatable, and depends to some extent on our definition of science. In any case we must turn for help to moral and spiritual sources of happiness if we are to continue to become increasingly indebted for material wealth to the scientific revelations of the interpretable universe. At present it appears that advancement in the power to enjoy and give contentment is more difficult for us collectively to acquire than advancement in the power to secure material benefit through science and engineering."